Intermediate Macroeconomics

Macro ≈ Economy wide outcomes or market outcomes

Inflation

GDP (≈ Sum of expenditures, Income, market value of production)

- Production → technology
- Prices → { • Cost of life, • Production Costs }

ECON 3311 – Spring 2025

UT Dallas

related to Real GDP

- Measure → growth
- Production function (model)
- Growth model

related to Nominal GDP ← Inflation too

Introduction

Adverse outcome that Central Banks will try to mitigate

- high/volatile inflation
- Deflation

In this chapter, we will examine:

What **inflation** is, how it is measured, and how **costly it can be** – why are central banks so worried about high inflation?

(1) How the **quantity theory of money and the classical dichotomy** (difference between real and nominal indicators) help us understand inflation

(2) The relationship between interest rates and inflation through the **Fisher equation**

↳ link policies with inflation outcomes

The important **link between fiscal policy and high inflation**

(1) About Money
(2) About Interest rates

} Related to Central Banks' policies

"Index": a number representing the level of a variable (here: prices' level)

Inflation

Inflation is the annual percentage change in the price level:

$$inflation\ rate_{t+1} = \frac{P_{t+1} - P_t}{P_t} \times 100$$

Index of the general level of prices

- The inflation rate we hear about in the news is the **Consumer Price Index (CPI)**
  - The main consumer price index measures the change in the price of a **basket of goods and services** purchased by the typical urban consumer
  - **Core CPI is the CPI without food and energy prices,** as these tend to be more volatile
- The **GDP deflator** is an inflation measure looking at all goods and services since GDP is used → Nominal GDP / Real GDP
- The different inflation measures tend to give relatively similar results over time

Problem of CPI: It a "set" composition of goods
→ Fix: The basket of goods is frequently updated

For Core CPI: Weight of Food & Energy are made 0

total CPI

CPI weights

Different categories of the CPI receive different weights depending on their importance in the consumption of a representative consumer

Item	Weight in CPI	Examples
Food and Beverages	14.26%	At home, restaurants
Housing	42.36%	Residence, utilities, furnishings
Apparel	2.46%	Suits, dresses, watches, shirts, etc.
Transportation	18.18%	New and used vehicles, gas, insurance, public transportation
Medical care	8.49%	Drugs, equipment, physician services
Recreation	5.11%	TVs, pets, toys, ticket prices
Education and Communication	6.41%	Tuition, postal service, wireless phone service, internet service
Other	2.74%	Tobacco, personal care, legal and financial services

Calculating inflation from the CPI

↳ helpful for comparing values across periods of time

The CPI is used to compare the prices between two periods:

This is done in a similar way to how we compared the price levels in two countries

Example: Suppose a dozen eggs cost $0.60 in 1950. While in nominal terms eggs are more expensive today, what about in real terms (adjusted for inflation)?

Suppose the CPI today is 100, and in 1950 it was 9.59.

$$\$0.60(1950\ dollars) * \frac{100\ (in\ 2023\ dollars)}{9.59\ (in\ 1950\ dollars)} = \$6.26$$ ("2023 dollars terms")

Suppose the CPI in 1990 was 52.05 and the price of a dozen eggs was $1.01. How much is that in today's money?.

$$\$1.01(1990\ dollars) * \frac{100\ (in\ 2023\ dollars)}{52.05\ (in\ 1990\ dollars)} = \$1.94$$ ("2023 dollars terms")

Hint: keep track of units

Another example: $10 in 1980 can afford more than $10 today

Note: we can compare past to Future values.
(But also "future" to "past" as in here)

Practice question

In 2015, The Avengers: Age of Ultron generated about $191.2 million on its opening weekend. In 2007, Spider Man 3 generated $151.1 million on its opening weekend. If the CPI in 2000 was 100, the CPI in 2007 was 113.4, and the CPI in 2015 was 137.6. What are the revenues (in 2000 dollars) of each movie?

$$\text{New Price of good} = \text{Old Price} \times \frac{\text{New Price Index}}{\text{old Price Index}}$$

↳ Can use same formula BUT solving for the old price:

$$\text{Old Price} = \text{New Price} \times \frac{\text{Old Price Index}}{\text{New Price Index}}$$

CPI(2007): 113.4

CPI(2000): 100

CPI(2015): 137.6

Revenue(Av): $191.2

Revenue(Sp): $151.1

$$\text{Av}: \underbrace{138.95}_{\text{↳ Revenue in year 2000's terms}} = 191.2 \times \frac{100}{137.6}$$

$$\text{Sp}: \quad 133.3 = 151.1 \times \frac{100}{113.4}$$

Hyperinflation

Money / Savings / Income lose a lot of value

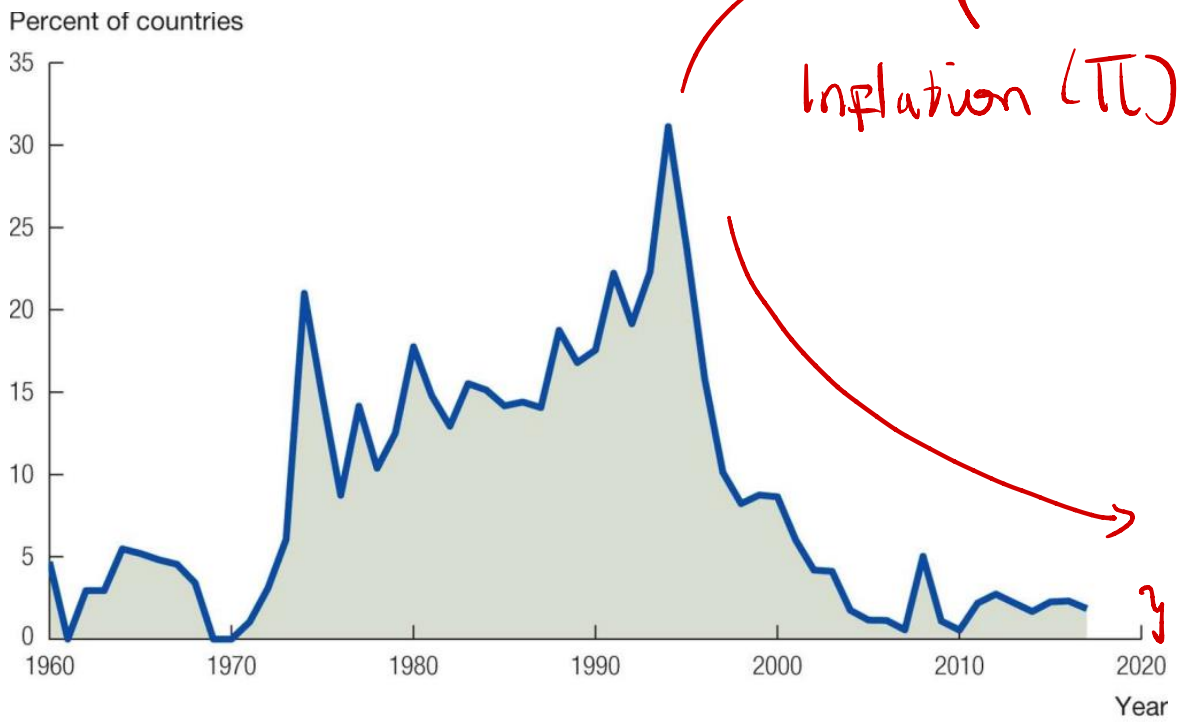
Hyperinflation: Episodes of inflation that are very high (more than 500 percent per year)

- Some examples include: Hungary (1945), Bolivia (1985), Brazil (1990), Russia early 1990s, Yugoslavia early 1990s, Zimbabwe 2008 (at one point prices doubled about every day)

While hyperinflation is extreme, prolonged periods of high inflation will also greatly hinder an economy's ability to function smoothly

World Inflation

In general, the number of countries in the world experiencing high inflation has been declining in recent decades:



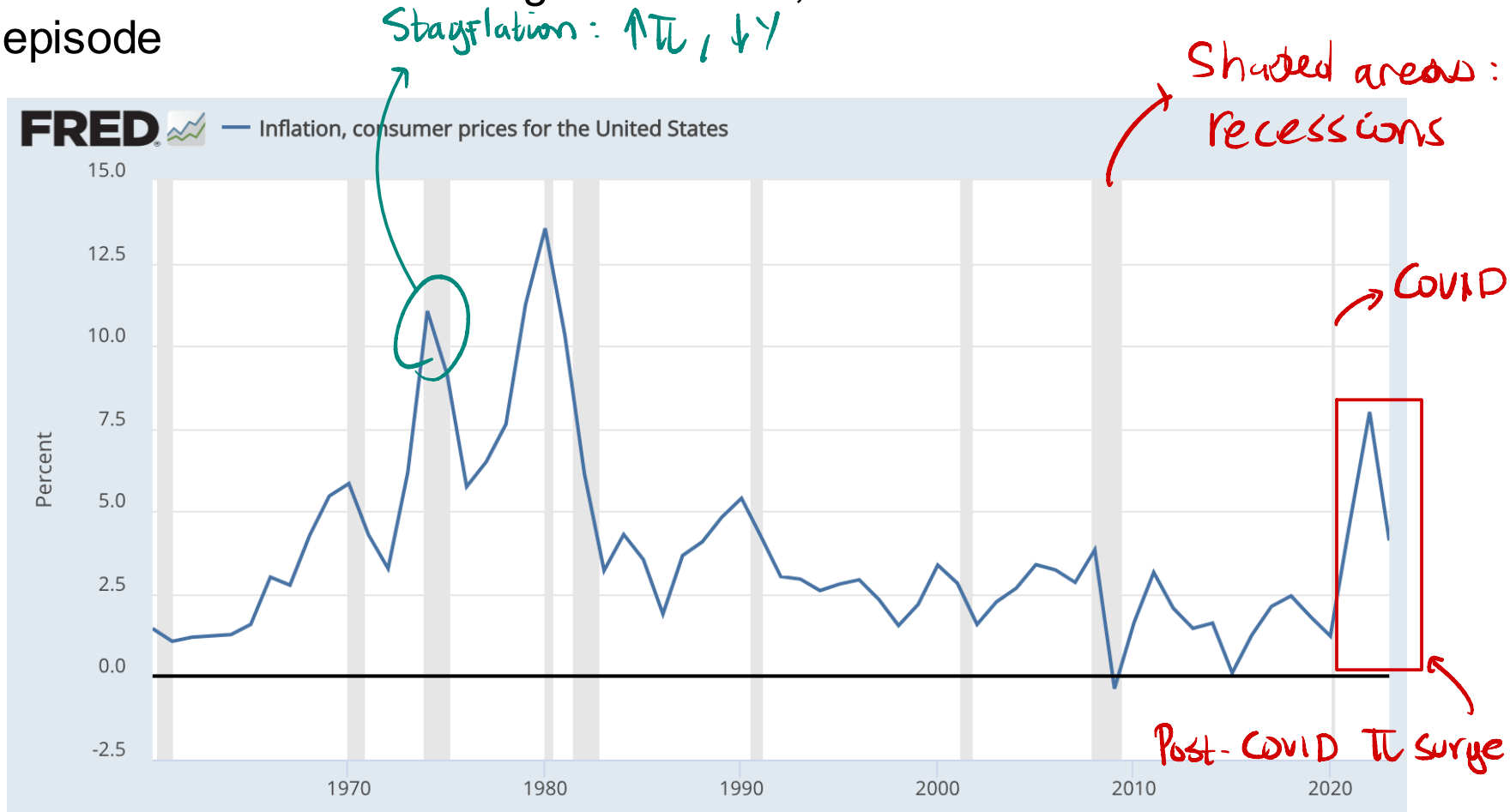
Source: FRED.

On average Central Banks have become more capable of Taming Inflation

Inflation rate in the United States

In the US inflation was low in the early 60's, then it rose sharply in the 70's, and after strong policy actions it fell in the subsequent years.

Recently we have witnessed a surge in inflation, but it is more moderate than the 70's episode

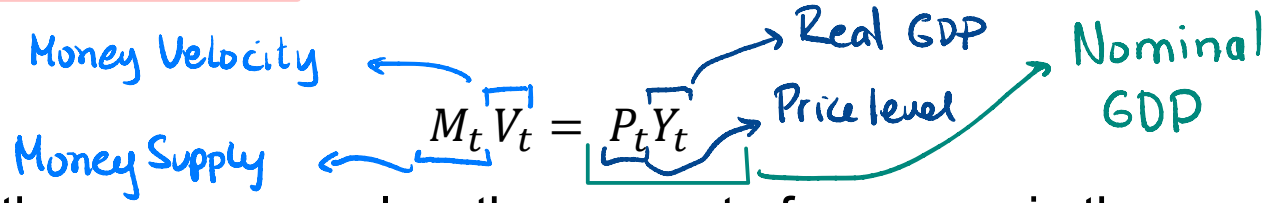


How to link Policy Actions & Inflation?

The Quantity Equation

"QTM"

The quantity theory of money allows us to make the connection between money supply and inflation through the following equation:



M_t represents the money supply – the amount of currency in the economy

V_t represents the velocity of money – the average number of times per year that each piece of paper currency is used in a transaction

P_t represents the price level

Y_t represents real GDP

Intuition: If more payments are made then either prices are higher or quantities produced increased

The equation states that nominal GDP (the right hand side) is equal to the amount of money used in transactions (the left hand side)

Separation

The Classical Dichotomy

We assume that real GDP is determined by real values and not nominal values like the money supply

GDP is determined by the investment rate, the amount of capital, total factor productivity, and new ideas that make us more productive—all of the factors we examined before.

- Therefore, we can assume that real GDP is exogenous in the QTM equation: $Y_t = \bar{Y}_t$
- We will assume that the velocity of money is both exogenous and constant, so there is no time subscript: $V_t = \bar{V}$
- M_t is determined by the central bank in a country through monetary policy (we will discuss this in more detail later)

In the context of this model, we will assume that the money supply is exogenous as well $M_t = \bar{M}_t$

Exogenous for QTM: $\bar{Y}_t, \bar{V}, \bar{M}_t$

Endogenous: P_t

$\Rightarrow$ can use QTM to solve for P_t

The Quantity Theory and the Price Level

We can then solve for the price level given $\bar{Y}_t, \bar{V}$, and $\bar{M}_t$

QTM: $M_t V_t = P_t Y_t$

given assumptions: $\bar{M}_t \bar{V} = P_t \bar{Y}_t$

$\Rightarrow$ rearranging $\rightarrow$ $P_t^* = \frac{\bar{M}_t \bar{V}}{\bar{Y}_t}$

We can see that **prices will increase (inflation)** if there is an **increase in the money supply** or if there is a **decrease in real GDP**

If both are increasing, the direction of change in the price level depends on which one is increasing more

We assume that V remains constant

For policy: $\uparrow M_t \rightarrow \uparrow P_t$ ($\downarrow$) ($\downarrow$) ($\downarrow$ Inflation)

To bring QTM to inflation: Set QTM equation in growth rates

The Quantity Theory and the Price Level

The quantity theory of money can also be expressed in terms of growth rates:

$\bar{M}_t\bar{V} = P_t\bar{Y}_t$

$\bar{g}_M + \bar{g}_V = g_P + \bar{g}_Y$ (0 (assumption))

$g_P = \pi$

If we set $\bar{g}_V$ to 0 and treat g_P as the inflation rate (π), then we can write:

$\frac{\bar{M}_t\bar{V}}{\bar{Y}_t} = P_t$

$\pi^* = \bar{g}_M - \bar{g}_Y$

2% 6% - 4%

Changes in the growth rate of money lead to changes in the inflation rate

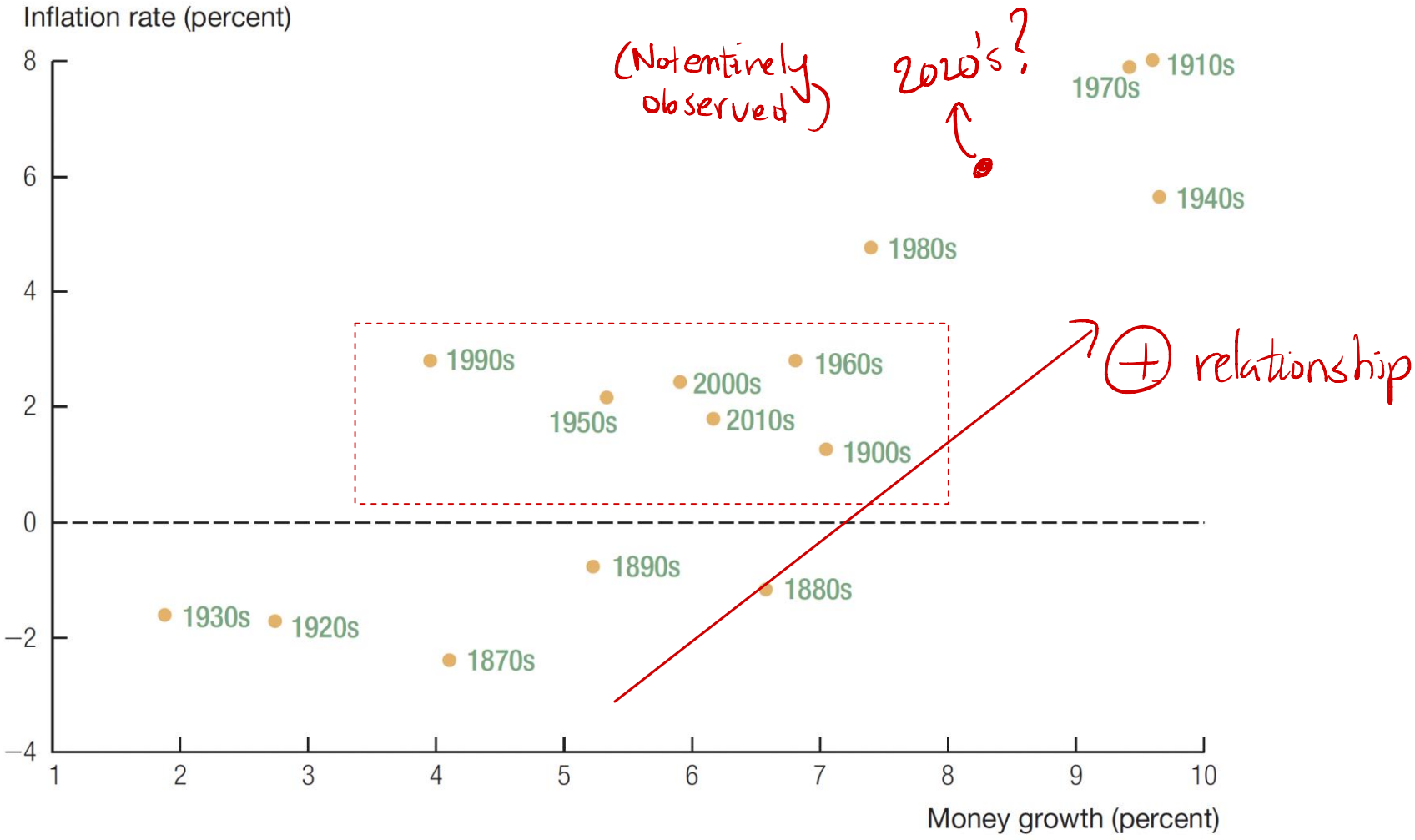
For instance, if real GDP is growing at 4% and the money supply is growing at 6% (and velocity is constant), then the inflation rate is 2%

If in the next year the money supply is growing at 7%, but real GDP still at 4%, then inflation will go up to 3%

Reminder $z = x + y \Rightarrow g_z = g_x + g_y$

$z = \frac{x}{y} \Rightarrow g_z = g_x - g_y$

Money growth and inflation (United States)



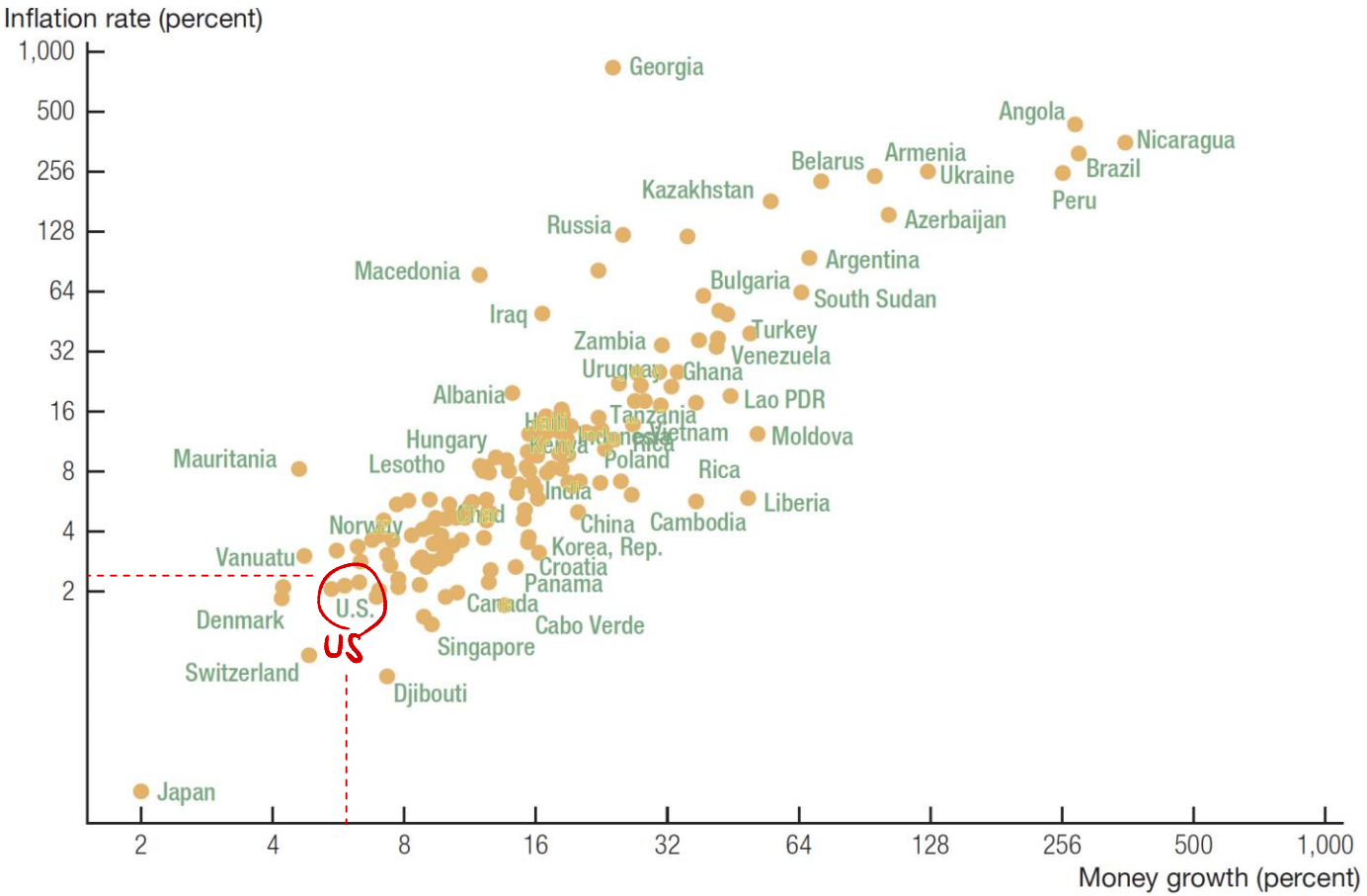
Sources: Money growth rates are computed using the data on M2 from the *Historical Statistics of the United States* (Cambridge: Cambridge University Press, 2006) and FRED. Inflation data are taken from www.measuringworth.com.

World Money Growth and Inflation (1990–2017)

While there are some outliers, not only is there a positive relationship between money growth and inflation, but it is close to a **one to one** relationship.

Rest of the world:

Even stronger relationship



Source: World Bank, *World Development Indicators*. The figure plots the average annual percentage change in the price level (inflation) and money supply for a sample of countries. Ratio scales are used for both axes.

Money (growth) won't affect the real economy in the long run (in the long-run money would affect only prices)

The neutrality of money

The neutrality of money is the idea that changes in the money supply have no real effect (**in the long run**) on the economy and will only affect prices

If there are the same amount of goods to go around, and just more money, then the **relative** prices of the goods will not change

* For instance, suppose that every dollar you have is replaced by 100 pennies

You just pay 'more' for goods and services, but you are not any better off or worse off in real terms

While this may not seem like a problem, there are severe costs to inflation, especially when it is unpredictable (more on this later)

→ But high/volatile π is still troublesome (in the short run)

* Double the money → Double the prices (everything else in real economy → unchanged)

→ But some short-run costs may still matter.

Interest rates

Interest rates are also linked to π
- They can be real & nominal

The interest rate represents the cost of borrowing/lending

It is important to differentiate between the real interest rate and the **nominal** interest rate

The real interest rate is measured in *goods* – how much a person can earn by saving one unit of output for a year or the amount a person must pay to borrow one unit of output for a year

- A unit of saving will turn into a unit of investment , which is a unit of capital
- So, the return to saving is equal to the return on capital, which is how much capital can be rented for

We saw in an earlier chapter that ***MPK = r***

The *real interest rate is equal to the rental price of capital which is equal to the marginal product of capital*

Real rate → in terms of goods (extra output from ↑savings (↑investment))

Interest rates

Nominal: In terms of money (the rate charged by banks)

extra $ from ↑ Savings at the bank

The nominal interest rate is measured in monetary terms –how many dollars can be earned by putting money in a savings account

The difference between the nominal interest rate and the real interest rate is the change in the price level (inflation)

We can see this in the following formula:

Nominal Interest rate

$$i = R + \pi$$

Inflation

Real Interest rate

This is called the **Fisher equation** and it states that nominal interest rates (i) are equal to real interest rates (R) plus inflation (π)

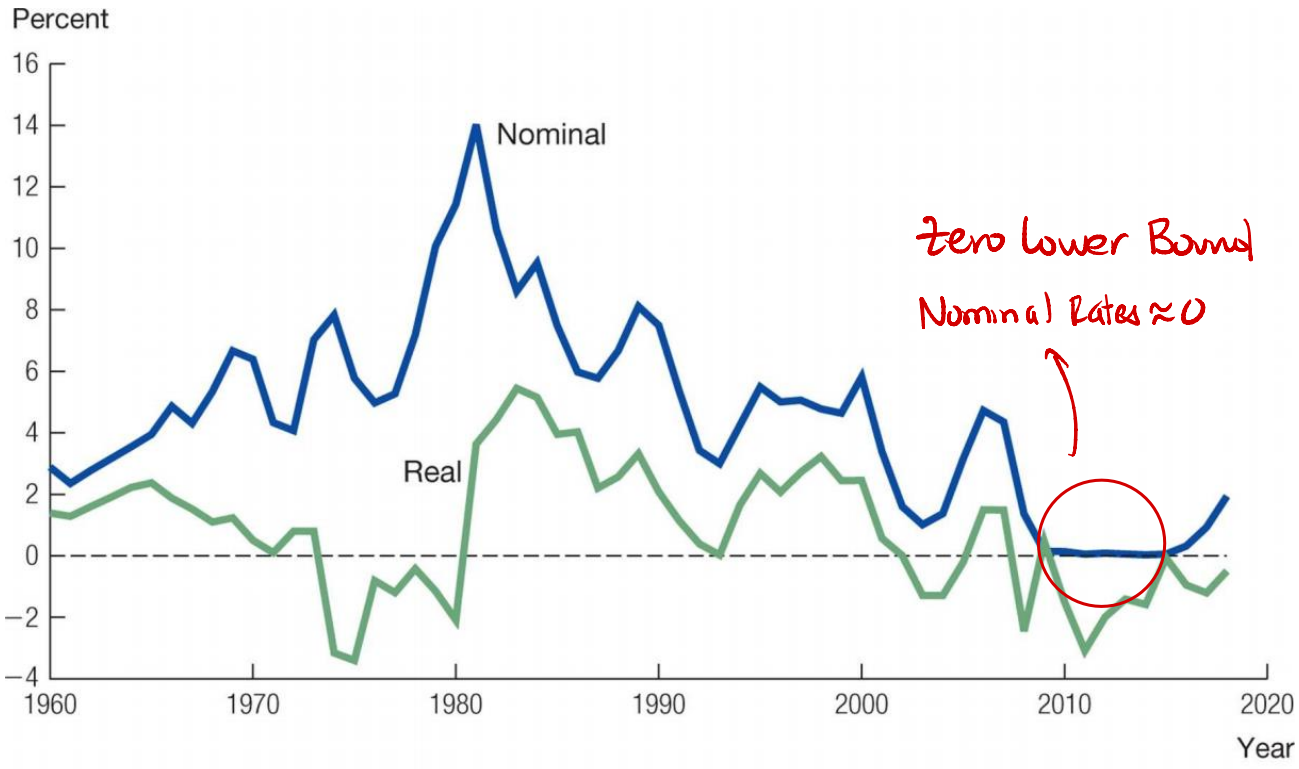
Note an implication: The real value of an investment cannot include the increase in price due to inflation

Real and nominal interest rates over time

$i = R + \pi$

Note that we see that empirically the interest rate has been negative

This may happen in the short run (the marginal product of capital cannot actually be negative) and is another example of making sure we are differentiating between short-run and long-run phenomena



Source: FRED and author's calculations. The nominal interest rate plotted here is the annualized return on 3-month Treasury bills.

To note, in real terms the MPK is the extra amount of output you produce by using one more unit of capital. This cannot be negative. Then, the plot shows that the real rate can actually depart from the MPK in the short run.

Costs of inflation

π does not matter for current productive capacity BUT it may still damage and erode wealth, income & worsen living conditions (in the short-run)

Why are we so concerned about inflation if nominal interest rates adjust and money is neutral? In particular if inflation is below 10%?

Suppose that you buy a house after graduation:

The house costs $250,000. You have a down payment of $50,000 and then a mortgage for the rest ($200,000) for 30 years

- If inflation is low and interest rates are 3% (e.g., Nov 2021) your monthly payment is **$843**
- If the inflation rate is higher and interest rates are 7% (Nov 2022) your monthly payment is **$1,330**

Over the term of the loan, the difference is $175,320

Intuition on costs: Imagine prices spike suddenly ⇒ a company may go out of business even if it due to a temporary (short-run) effect.

Costs of inflation

Suppose you are saving up for retirement and the last five years you were working, inflation went up by 8% per year, when it was usually 3% per year

- The value of your retirement savings will decrease if inflation is not matched by increasing returns

Other costs have to do w/ process of adjusting prices or even "Shopping around"

Two additional costs with inflation are:

Shoe-leather costs: You are constantly going around (physically and mentally) trying to make sure money doesn't lose value

Menu costs: Firms having to change prices all the time

Inflation is going to be most costly when it is unexpected

Contracts and agreements are based on one expectation and the reality turns out to be different

Importantly: too high / too volatile π → may lead to lower Savings & Investment

Fiscal causes of high inflation

If inflation is so costly, why would the money supply be increased if it is going to cause inflation?

We can examine this through the government budget:

Just like us, the government has expenditures and revenues

$$G = T + \Delta B + \Delta M$$

Taxes

Gov. Spending

Debt

Money

Gov. Spending can be funded with ↑ money

Trade-off: Inflation

G represents government spending

T represents tax revenue

B represents the government debt, so a change in B is new borrowing/debt

M represents the stock of money, so a change in M is new money issued by the government

Back to Policy: Too much Gov. Spending may create Inflation!
(fiscal)

Fiscal causes of high inflation

Suppose the government wants to increase spending on healthcare by $100b.

This extra purchase (increase in G) has to be financed by one of the sources of funds so the government can:

- Cut other spending (decrease in other uses of G)
- Increase taxes (T)
- Borrow more money from US and foreign citizens (B)
- Print money (M)

What happens if the government prints money?

$\uparrow M_t \bar{V} = \uparrow P_t Y_t$ (or $\uparrow \pi = \uparrow(g_M - g_Y)$)

"Inflation tax" ⟶ Gov Makes ↑M → ↑Inflation
⇒ money held by public loses value

Fiscal causes of high inflation

'Inflation tax' refers to the idea that the government is **'taxing'** the rest of the economy when it prints money

Suppose the government spending of $100 billion printed by the central bank doubles the amount of currency

- Every dollar held by the public is now worth half of what it was worth before
- People are paying twice as much for the same goods
- Those people holding **'real'** assets are not affected that much
- But those people holding currency are seeing a sharp decrease in the value of what they have

This is why increasing the money supply (printing money) is a **last resort**

all of this: key to understand Argentinian Case & Post Covid Inflation

Central Bank Independence

Central bank independence refers to the idea that the central bank and the body in charge of government spending are separate institutions

- The government cannot just print money to cover its expenses
- While this may work in the short-term (and help officials get re-elected), in the long-run this only causes inflation
- Central banks are worried about the overall health of the economy in both the short-run and long-run

To prevent Inflationary Fiscal Policy Incentives:

Separate institutions in charge of G from those in charge of M

Conclusion

Inflation represents the **annual percentage change in prices**, which can be shown through the **quantity theory of money** and the following equation:

$$\pi^* = \bar{g}_M - \bar{g}_Y$$

The **neutrality of money** is the idea that the real side of the economy is not affected by the nominal side – e.g. printing money will not increase GDP

→ Long run concept; in contrast, in short-run money (prices) affect real economy

The nominal and real interest rates are related through the Fisher equation:

$$i = R + \pi$$

All high rates of inflation are costly, **in particular when inflation is unexpected**

The **government budget** constraint depicts how increasing the money supply can help pay for government spending, which is a resource of last resort for governments unable to raise funds in other ways