Intermediate Macroeconomics

Monetary Policy and the Phillips Curve

before: IS curve
(aggregate Demand shocks)

ECON 3311 – Fall 2024 — Upon shocks: IS shifts
⇒ Output, Int. Rates change

UT Dallas

Now: Policy → can also shift IS
can act like (and offset) shocks

Monetary Policy: Central Bank (US: Federal Reserve)

→ Set Money Supply → Interest Rate (Nominal)

Introduction

In the model: MP Curve

In this lecture we will go over:

- How the **central bank sets the real interest rate** in the short run
  - This rate is going to be the **'MP' curve** in our short-run model
- How the **Phillips curve** describes the way firms set their prices which explains how inflation is determined.
- How the **IS curve, the MP curve, and the Phillips curve combine** to make up our short-run model

Short Run Model: MP + IS + PC

- How to analyze the evolution of the macroeconomy in response to changes in policy or economic shocks

Policymaking: Not Easy → Main Trade-off: $\underbrace{\uparrow \text{GDP vs. } \uparrow \text{Inflation}}_{\text{In the model: Phillips Curve}}$

Short Run Model: (MP + IS + PC) → Jointly determine equilibrium of the economy

IS: Investments / Savings : Output vs. Interest rate

MP: Money → Nominal Rates ⇒ Real Interest Rate

PC: Output vs. Inflation

Introduction

Our short run model will end up consisting of three curves:

1. **IS curve:** Relationship between the real interest rate and short-run GDP
2. **MP (monetary policy) curve:** Relationship between the nominal interest rate and real interest rate

   Real and nominal interest rates move together (in the short-run), so by setting the nominal rate the federal reserve is 'setting' the real interest rate

3. **Phillips curve:** The relationship between short-run GDP and inflation

Due to prices NOT adjusting instantly → R & i move together (in short run)

Introduction

① Policy: $i \Rightarrow R$ (MP)

② given $R \Rightarrow$ Demand $\Rightarrow \tilde{Y}$ (IS)
($C, I, \ldots$)

③ $\uparrow \tilde{Y} \rightarrow \uparrow \Delta\pi$ (PC)

$\Rightarrow \uparrow i \rightarrow \uparrow R \rightarrow \downarrow \tilde{Y} \rightarrow \downarrow \Delta\pi$

Central bank
Sets i
(Money Supply)

Nominal interest rate, ~~I~~ i	① **MP curve** →	Real Interest Rate, R	② **IS curve** →	Short-run output, $\tilde{Y}$	③ **Phillips curve** →	Change in Inflation, Δπ

$i = R + \pi$

w/ i set R is determined

Fed: Sets Federal Funds Rate → Rate at which Fed lends $ to banks (in overnight markets) *

↳ Leads to changes in rates set by Commercial banks → i : Nominal Interest Rate

The MP Curve

When banks borrow money from each other, they will do so at the **federal funds rate** set by the central bank (Federal Reserve in the U.S.)

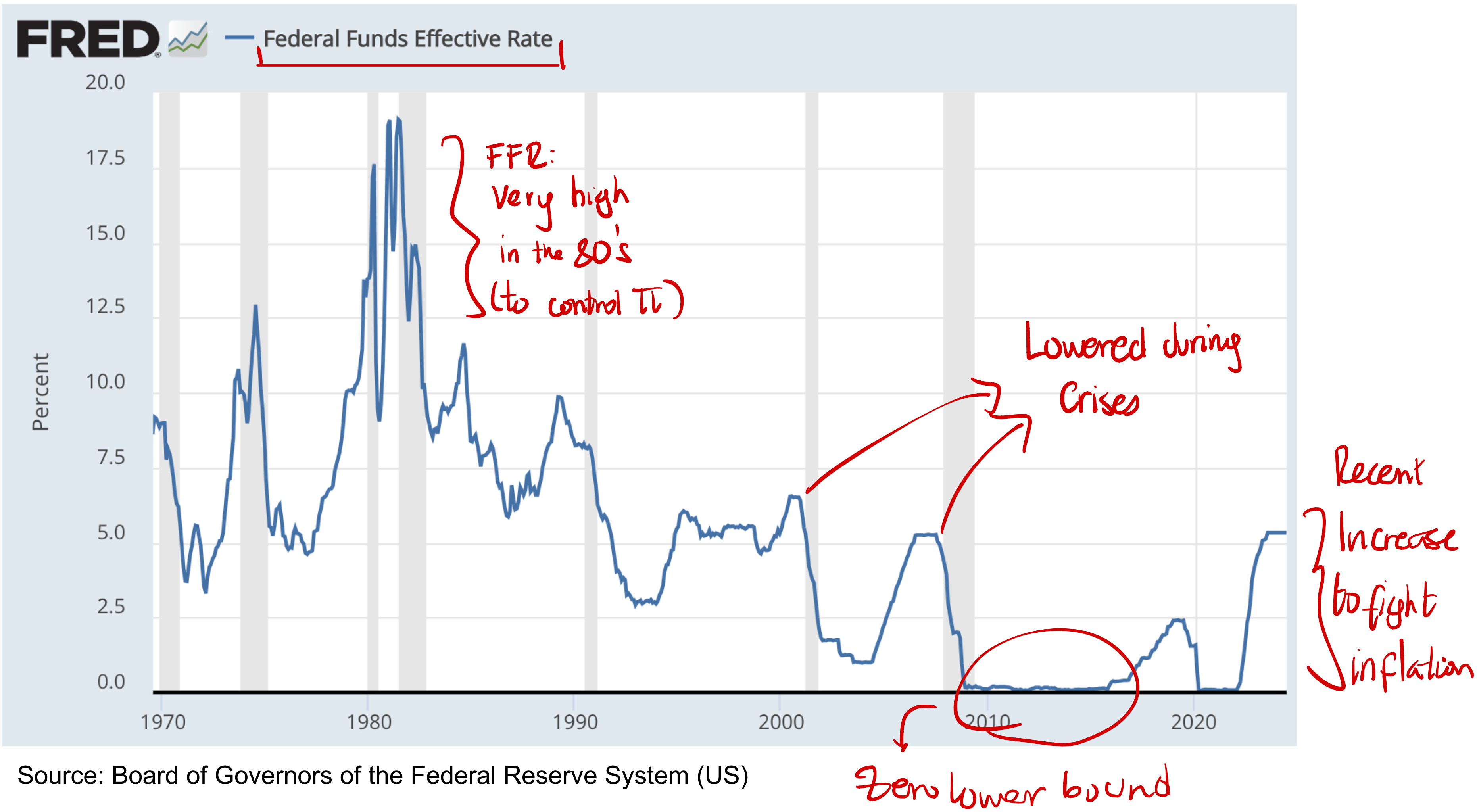
This is the key policy tool the central bank uses to influence the economy

- If the banks charged a higher rate, then everyone would use the central bank
- If the banks charged a lower rate, then everyone would borrow from them and lend to the central bank at a higher rate and the bank would run out of money
    - All banks act this way and therefore the rate is the same for every bank

* This is money from other banks (held as reserves at the Fed) ⇒ The FFR is a type of "interbank interest rate"

Federal funds rate over time

- While the federal funds is much higher today than a year ago, historically it has often been much higher
- Especially in the early 1980s when the Fed took drastic measures to fight inflation
- The recent increases in the rate is also related to the recent —post COVID— inflation surge



Source: Board of Governors of the Federal Reserve System (US)

Fisher equation

Inflation move slowly (Prices are "Sticky") $\Rightarrow$ Real Rate changes w/ i
$\Rightarrow$ Central Bank sets R by adjusting i

Recall the Fisher equation from before: The nominal interest rate (i) is equal to real interest rate (R) plus inflation (π),

$$\underbrace{i}_{\text{Nominal Rate (Set by Fed)}} = \underbrace{R}_{\text{Real Rate}} + \underbrace{\pi}_{\text{Inflation}}$$

$R = i - \pi$

The nominal rate is set by the central bank

After a change in the nominal rate the real interest rate changes unless such a change is offset by inflation.

We will assume **'sticky inflation'** in the short run, meaning inflation:

- Displays inertia
- **Adjusts slowly** over time
- Does not respond immediately —that is within about 6 months— to monetary policy in a direct fashion

Due to this stickiness, **central banks can set the real interest rate in the short run**:
See this yourself … with π constant or still any changes in i are met by changes in R

example: $\pi = 2\%$ $R = 1.5\%$ $i = 3.5\%$ $\Rightarrow$ Change: $i' = 4.0\%$ $\Rightarrow \begin{cases} R = 2\% \\ \pi = 2\% \end{cases}$ In the very Short run

We don't know π for the next year...
Then how to decide to get indebted?

Adjusted Fisher equation

If what we care about is R
→ Use expected π

We can adjust the Fisher equation by replacing the actual inflation rate with the expected inflation rate:

$$i_t = R_t + \pi_t^e$$

→ Expected Inflation

π_t^e denotes the rate of inflation people **expect over the next year**

When making a decision on whether to borrow or not, one must make a prediction (expectation) on what inflation will be

⇒ Two versions of R:

We will have two **different versions** of the **real interest rate**:

$$R_t^{ex\ ante} = i - \pi_t^e \qquad R_t^{ex\ post} = i - \pi_t$$

$R^{ex\text{-}ante}$ → Used for making debt/demand decisions

$R^{ex\ post}$ → actual Real Rate Observed

Investment decisions are based off of the first equation (ex ante)

FFR (i) is determined exogenously by the Fed

$\Rightarrow$ MP curve is represented as a constant in the plot

The MP Curve

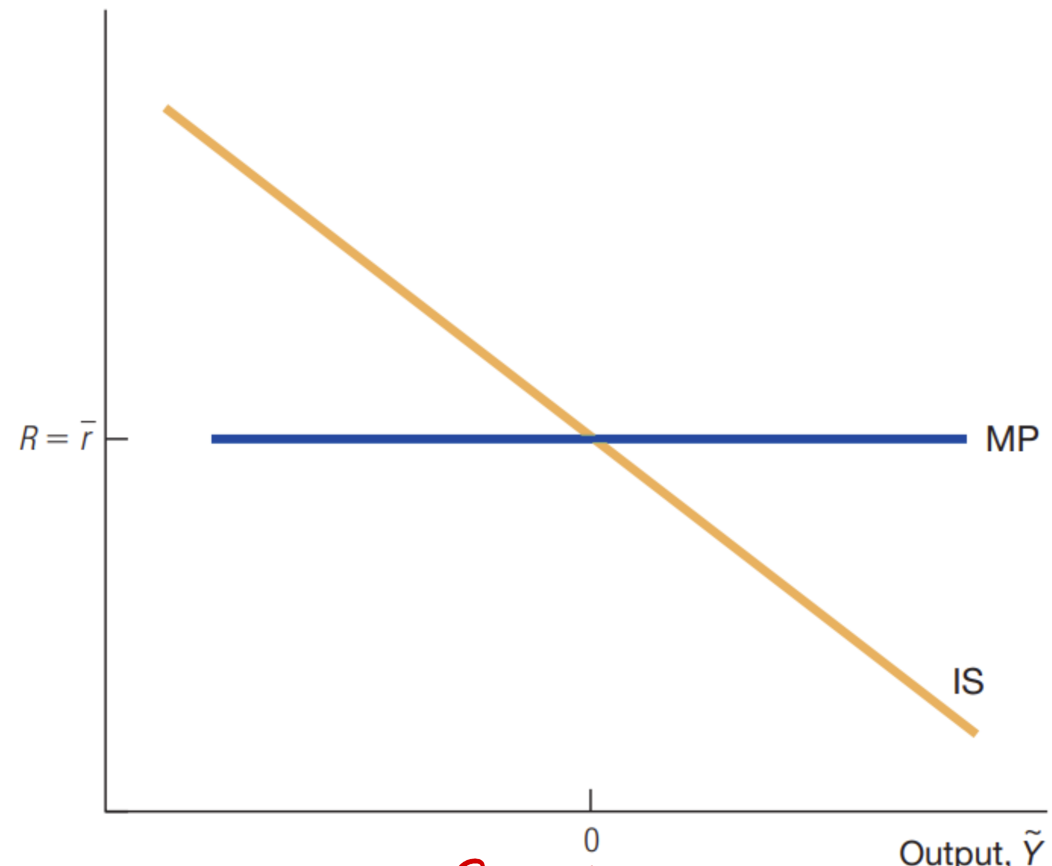
The MP curve is plotted on the same graph as the IS curve

It is horizontal because it is the rate that is set by the central bank (exogenous)

As a baseline we assume R is set at the MPK so that short-run output does not deviate from its long-run value

Reminder: In the long-run the real interest rate (R) will equal the marginal product of capital ($\bar{r}$)

The MP Curve in the IS-MP Diagram



to begin (Prior to shocks) $\rightarrow$ R is set at MPK: $R = \bar{r}$ (long-run value)

The MP Curve

MP Shifts w/ policy:

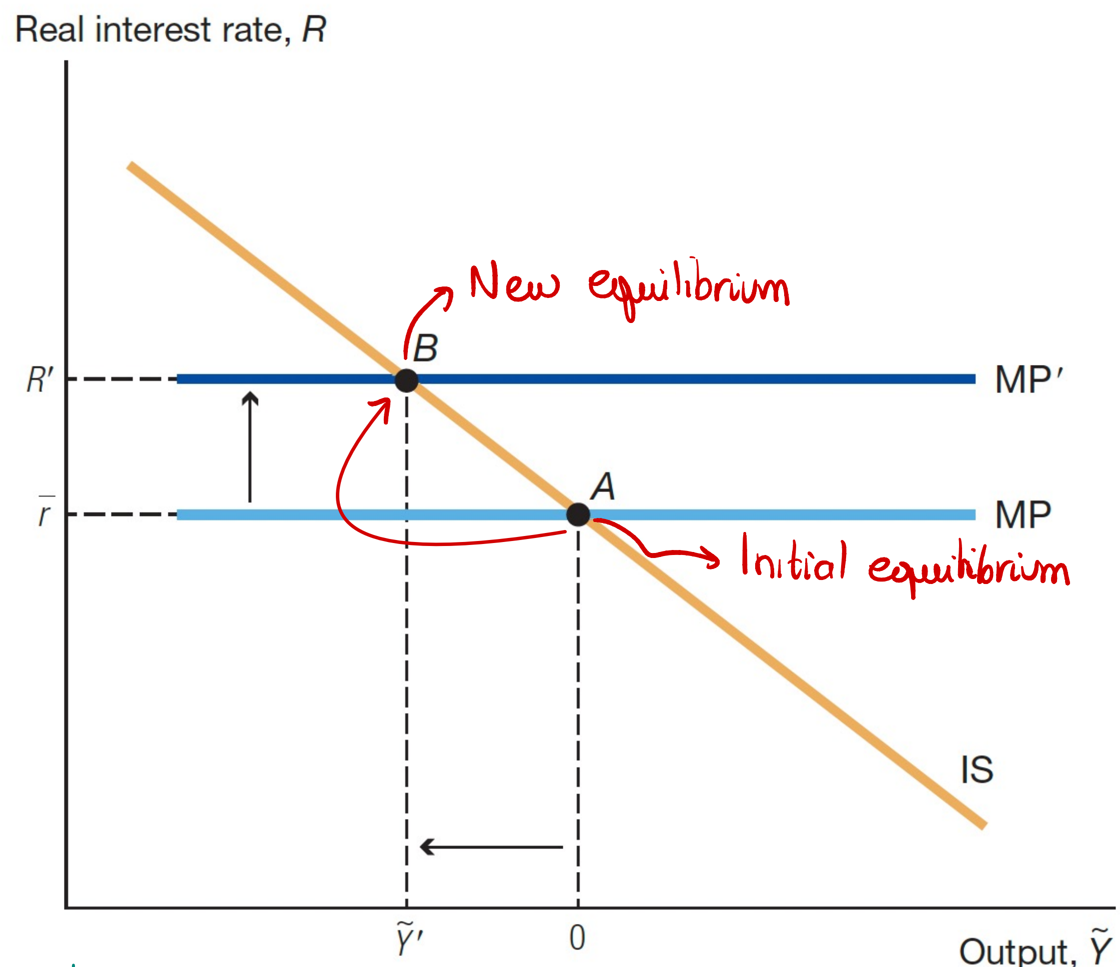
- Central bank ↑ Rates ⇒ MP Shifts up
↓ (down)

Suppose the central bank decides to **raise the nominal interest rate**

Because inflation does not instantaneously adjust, the **real interest is increased** when the nominal interest rate is increased

Investment will decrease because the real interest rate is above the marginal product of capital

Raising the Interest Rate in the IS-MP Diagram



↑Nom. Rate ⇒ ↑R ⇒ Demand ↓

W/o any adjustment in inflation

(Investment ↓): ↑$(R-\bar{r})$ ⇒ Output ↓ ($\downarrow \tilde{Y}$)

Housing Bubble Example

Upon shocks... there is a role to be fulfilled by Policy

Let's apply consider the housing bubble we talked about before

Suppose the economy starts out at the long-run equilibrium

Decrease in housing prices shifts the **IS curve to shift to the left**:

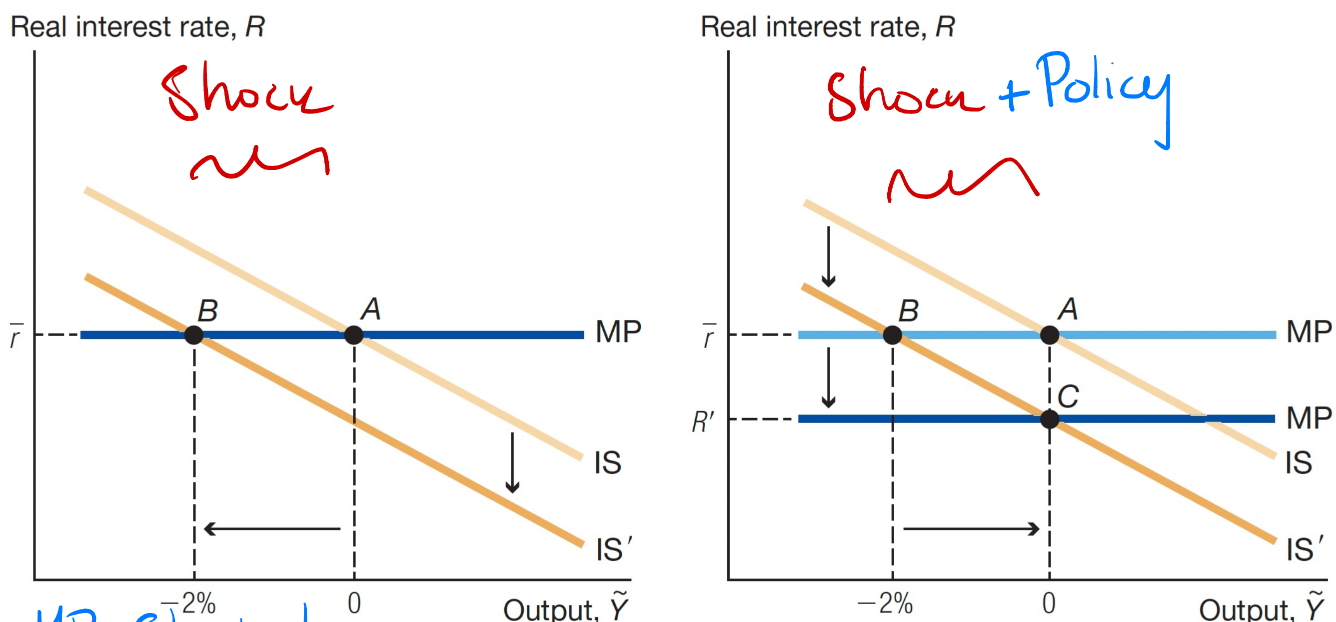
- Decrease in consumer confidence and wealth

Central bank response: Lower nominal interest rate

→ MP Shifts ↓

Inflation takes time to adjust and thus the **real interest rate lowers**: The economy moves to point C.

Stabilizing the Economy after a Housing Bubble



A: Initial (Pre-shock) equilibrium

B: Equilibrium w/ Shock

C: Equilibrium w/ Shock & w/ Policy

① Shock: ↓ housing Prices ⇒ Demand ↓, ↓ $\tilde{Y}$

② But with Policy ↓R to R′ → ↑ demand, ↑ $\tilde{Y}$ (Offsetting ①)

The Phillips Curve

$\tilde{y}$ & π relationship (Policy tradeoff)

We talked about the **Phillips Curve** in general terms earlier

Here we examine it in more detail

The basic idea is that producers and firms have an expectation of what inflation will be (e.g. 4%) and **set their prices accordingly**

What if they start thinking demand is lower than what they expected?

They might increase prices by less than their original expectation and plan

We can see this idea in the following formula:

Intuition: Firms adjust pricing decisions: lower (increase) prices further if the economy/demand is slow (booming)

$$\pi_t = \underbrace{\pi_t^e}_{\text{expected inflation}} + \underbrace{\bar{\nu}\tilde{Y}_t.}_{\text{demand conditions}}$$

We can assume that expected inflation is equal to last year's inflation:

$$\pi_t^e = \pi_{t-1}$$

To simplify: Assume people expect inflation to be the same as before

Let $\pi_t^e = \pi_{t-1} \Rightarrow$ Phillips Curve:

The Phillips Curve

$\pi_t = \pi_{t-1} + \bar{v}\tilde{Y}_t$

$\pi_t - \pi_{t-1} = \bar{v}\tilde{Y}_t \longrightarrow \Delta\pi_t = \bar{v}\tilde{Y}_t$

If $\uparrow \tilde{Y} \rightarrow$ Inflation is higher than before (or than expected)

$\uparrow \Delta\pi$

With that the Phillips curve can be depicted as:

$$\pi_t = \pi_{t-1} + \bar{v}\tilde{Y}_t$$

If output is **below** potential: Prices will rise more slowly than usual

If output is **above** potential: Prices will rise more rapidly than usual

Another way to express the Phillips curve is:

$$\Delta\pi_t = \bar{v}\tilde{Y}_t$$

If $\tilde{Y}_t > 0$ (Output higher than potential)

$\Rightarrow \Delta\pi > 0$ (Prices grow by more now)

Then, inflation would rise when the economy booms and lowers during a recession (we saw this in the data before)

$\tilde{Y}_t = (Y_t - \bar{Y}_t)/\bar{Y}_t$

$\Rightarrow$ In booms $\rightarrow \pi$ accelerates

(recessions) (slows down)

$\pi_t - (\pi_t^e)$: how higher π is relative to what was expected

π_{t-1} : Simplification

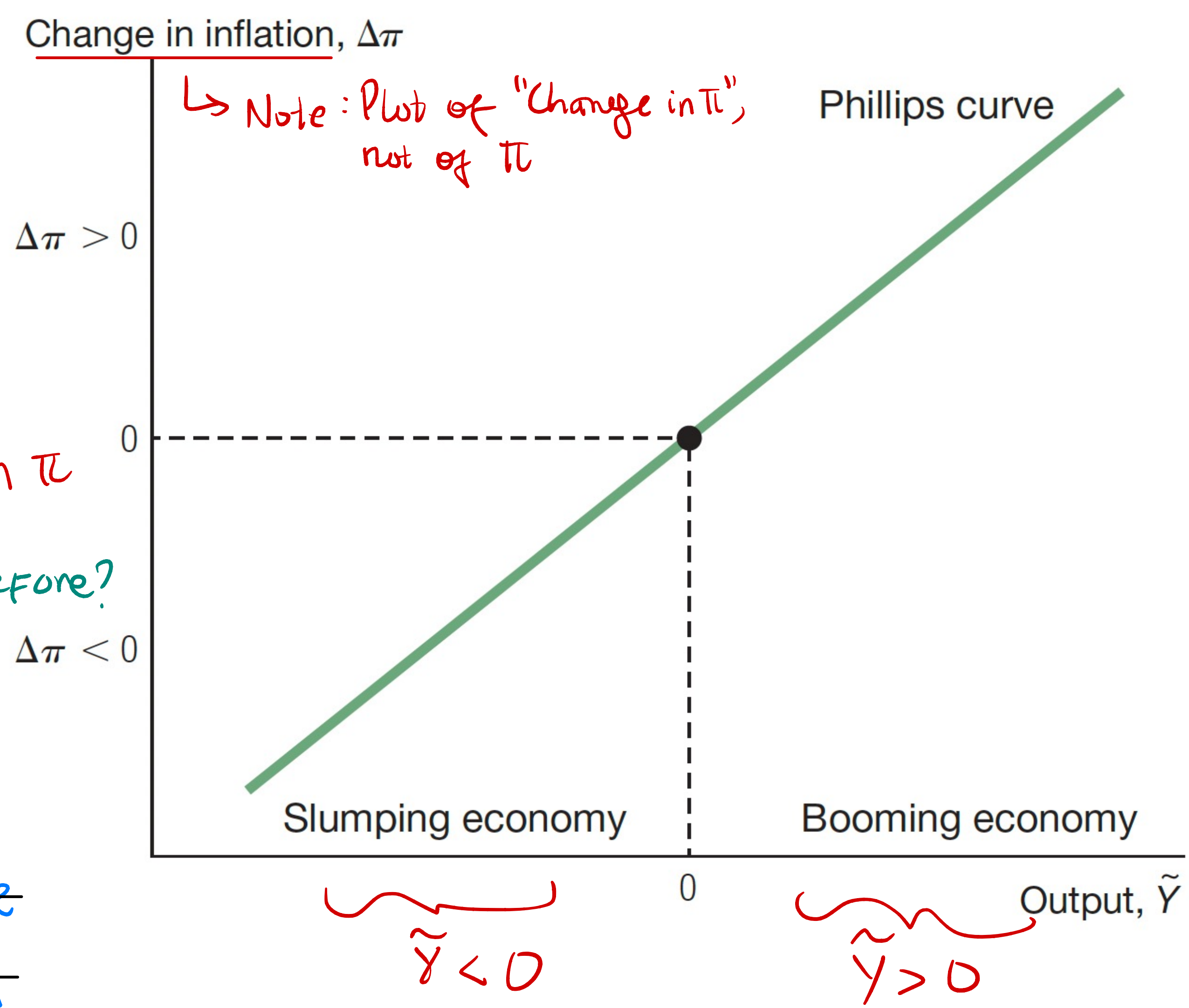
Plotting the Phillips Curve

We can graph the Phillips curve using the equation from the last slide:

$$\Delta\pi_t = \bar{v}\tilde{Y}_t$$

$\pi_t - \pi_{t-1}$: Acceleration in π

is π increasing relative to before?



Wrong Interpretation:

$\Delta\pi$ → ~~Inflation is negative~~
~~Prices are decreasing~~

example: $\pi_{2024} = 3\%$ $\pi_{2023} = 4\%$ ⇒ $\Delta\pi_{2024} = -1\%$

Add a shock to the Phillips curve: Prices shock $\bar{\theta}$

Example: An Oil Price Increase

We can add shocks to the Phillips curve and it becomes

$$\Delta\pi_t = \underbrace{\bar{v}\tilde{Y}_t}_{\text{Demand Side Features}} + \bar{\theta}$$

→ Shocks to Prices (Supply)

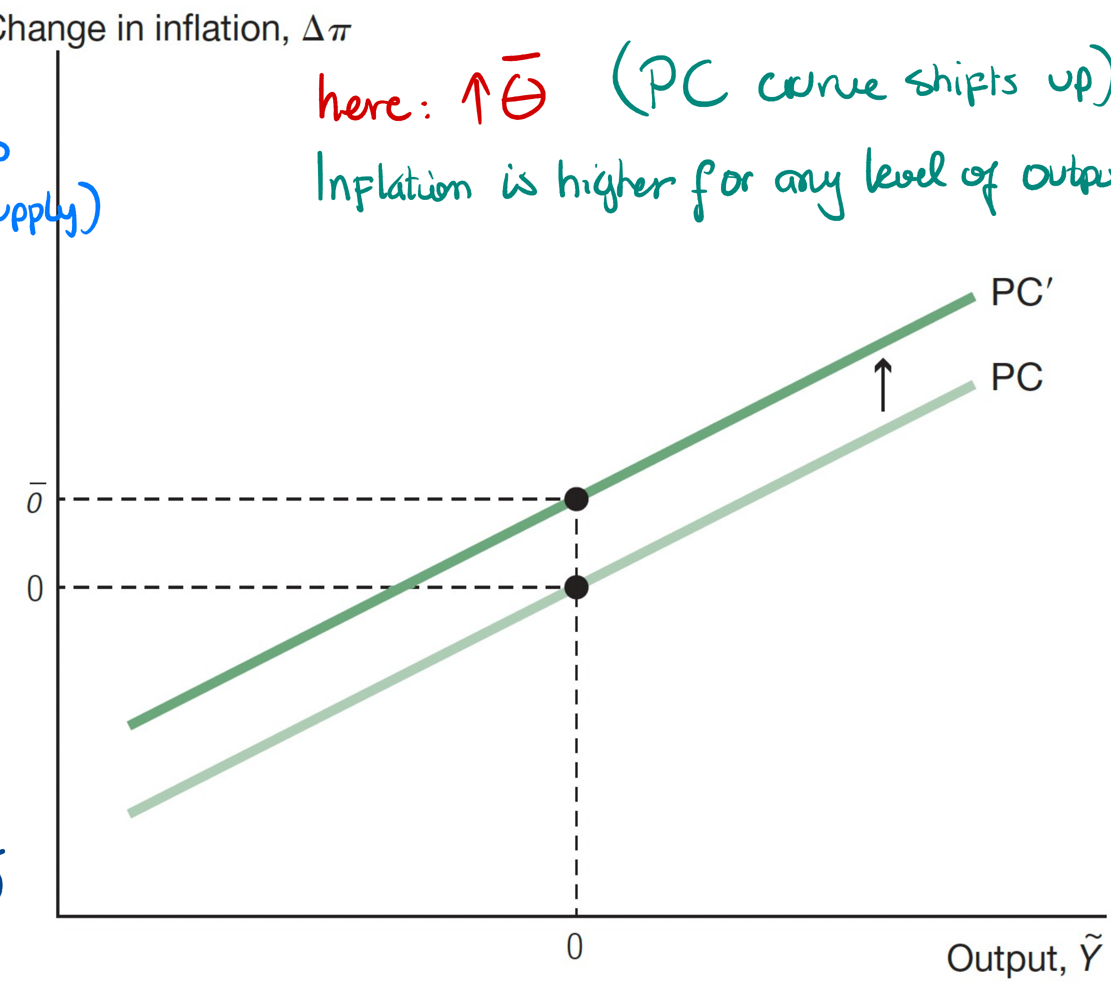
Possible "shocks":

- Expectations of inflation π^e
- Demand conditions $\tilde{Y}$
- Shocks to inflation θ (specific or general prices)

Example:
at $\tilde{y}=0$ $\Delta\pi = \bar{v}(0) + 0 = 0$
After shock $\bar{\theta} > 0$
at $\tilde{y}=0$ $\Delta\pi = \bar{v}(0) + \bar{\theta} = \bar{\theta}$

An Oil Price Increase

here: $\uparrow \bar{\theta}$ (PC curve shifts up)
Inflation is higher for any level of output.



What is $\bar{\theta}$? → "Cost Push" shock

→ Production Costs ↑ ⇒ Firms must raise prices

(Supply side shock)

Types of Inflation

Inflation can come from two sources in general:

1. **Cost-push inflation:** Price shocks (e.g. oil, steel, wages etc.) to an input in production
   - Increases in costs push up inflation
2. **Demand-pull inflation:** Changes in short-run output (e.g. increase in aggregate demand)
   - Increases in aggregate demand pull up inflation

↑ Demand → ↑ Prices

(Captured w/ $\tilde{y}$)

In addition to oil prices, **wages** make up a big part of the production costs

If **wages increase** firms may **increase prices**, leading to inflation

These components are visible in the simplified Phillips curve from before:

$$\Delta\pi_t = \bar{v}\tilde{Y}_t + \bar{\theta}$$

PC, QTM: $\neq$ relations between Y & π $\longrightarrow$ Supply vs. Demand effects

Phillips Curve and Quantity Theory of Money

The quantity theory of money and the Phillips curve seem to state different theories with regards to inflation

In growth rates:

Quantity theory of money:

$$M_t V_t = P_t Y_t$$

$\pi_t = \bar{g}_m - \bar{g}_y$

(or $\Delta\pi < 0$)

(demand side)

- An increase in real GDP leads to a decrease in inflation

Phillips curve: An increase in GDP will increase inflation

$$\Delta\pi_t = \bar{v}\widetilde{Y}_t + \bar{\theta}$$

$\longrightarrow \uparrow \tilde{y} \Rightarrow \Delta\pi > 0$

(Supply side)

Is one of them wrong?

No, one refers to a long-run relationship and the other to a short-run model.

Using the Short-run model

We can now use the short-run model to see how it can determine output and inflation over time in an economy:

1. Disinflation
    - Sustained reduction to a lower and stable rate of inflation
2. The Great Inflation of the 1970s
    - Example of how misinterpreting a productivity slowdown for a recession contributed to rising inflation.

Discussed before: Misdiagnosing Potential output and Output gap can lead to policy errors

(e.g., making recessions worse or to inflating the economy too much) → (e.g. Post Covid)

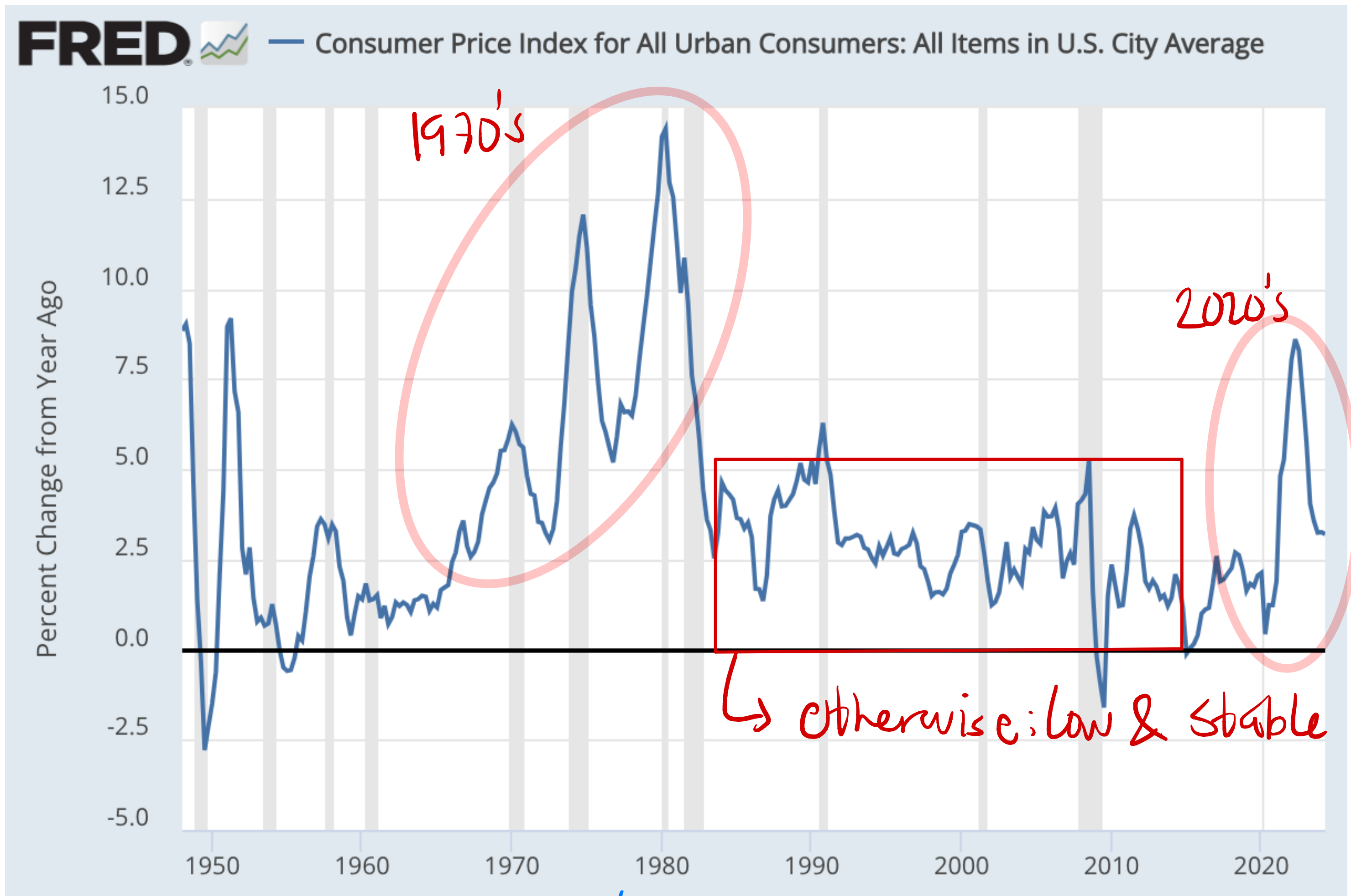
Inflation in the United States

Salient episodes:

Post War II inflation rate

1970's stagflation

Post-pandemic rise



Source: U.S. Bureau of Labor Statistics

1980's: Strong Policy efforts to lower π

Using the Short-run model

1980's: Policies to reduce π

Early 1980s give us an example of the policies a central bank can implement to fight inflation

In the long run, reducing the level of inflation requires tight monetary policy

- A sharp reduction in the rate of money growth } $\downarrow$Money or $\uparrow$Interest Rate (Nominal)

Since inflation is sticky, the classical dichotomy is unlikely to hold in the short run

- A decrease in money growth will not slow down inflation immediately

+ Sticky π : $\Rightarrow$ $\uparrow$ Real Interest Rate

The real interest rate will increase and induce a recession

- The recession causes negative changes in inflation
- As demand falls, firms do not raise prices by as much (if at all)

$(\uparrow i) \rightarrow \uparrow R \Rightarrow \downarrow \tilde{y} \xrightarrow[\text{(given } \tilde{y}, \pi \text{ trade off}]{} $ but also: $\downarrow \Delta\pi$

Using the Short-run model

$\uparrow R$ from $\bar{r}$ to R'
(Real rate hike/increase)
$\hookrightarrow MP \rightarrow MP'$

How to see this policy intervention graphically:

The higher rate is seen as a shift up in the MP curve

The higher rate is larger than $\bar{r}$

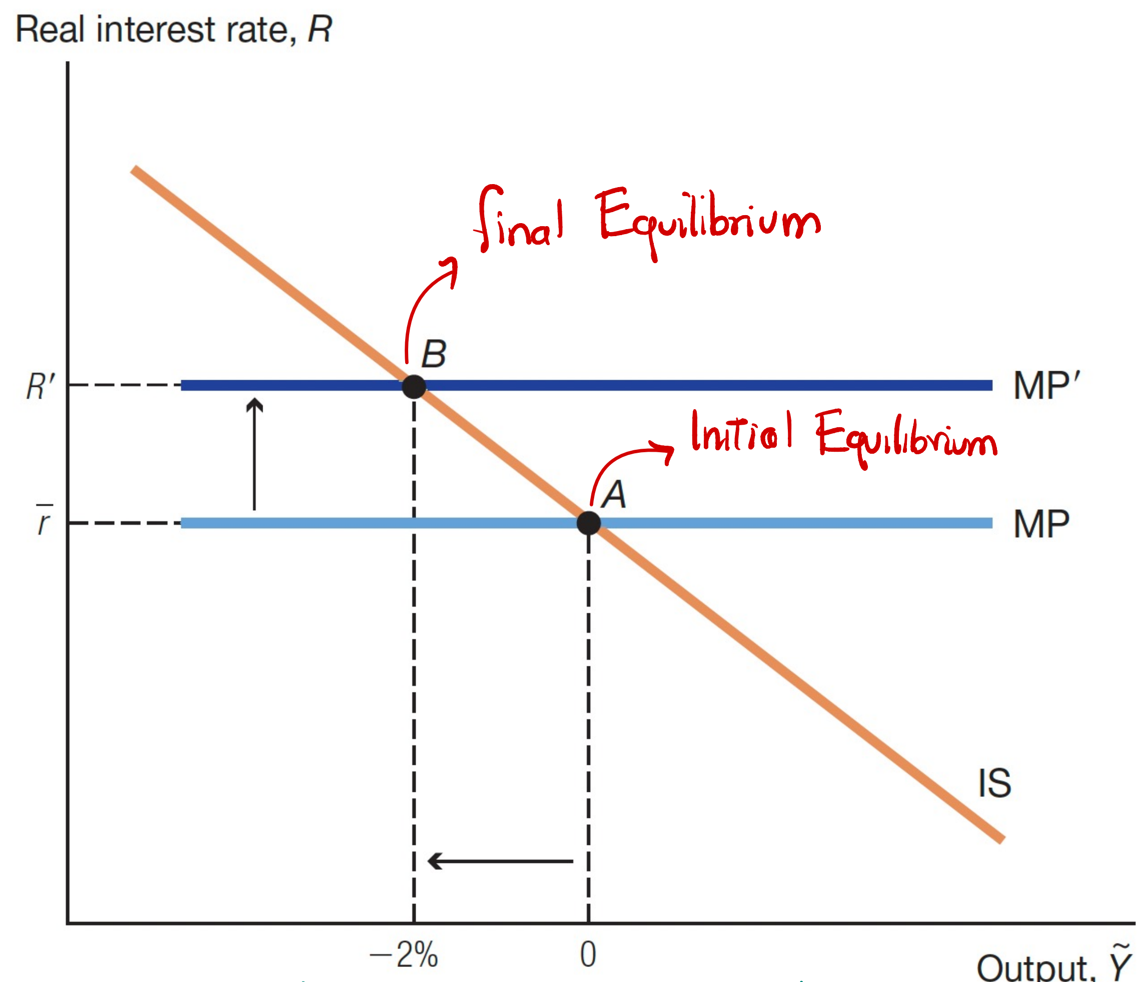
Thus Investment lowers which increases output

$\uparrow MP$: $MP \rightarrow MP'$

Economy goes from A to B:

- $\downarrow \tilde{y}$
- $\uparrow R$

Tightening Monetary Policy



(Still must use PC to see what happens to $\Delta\pi$)

Using the Short-run model

The drop in output is also reflected in the Phillips curve

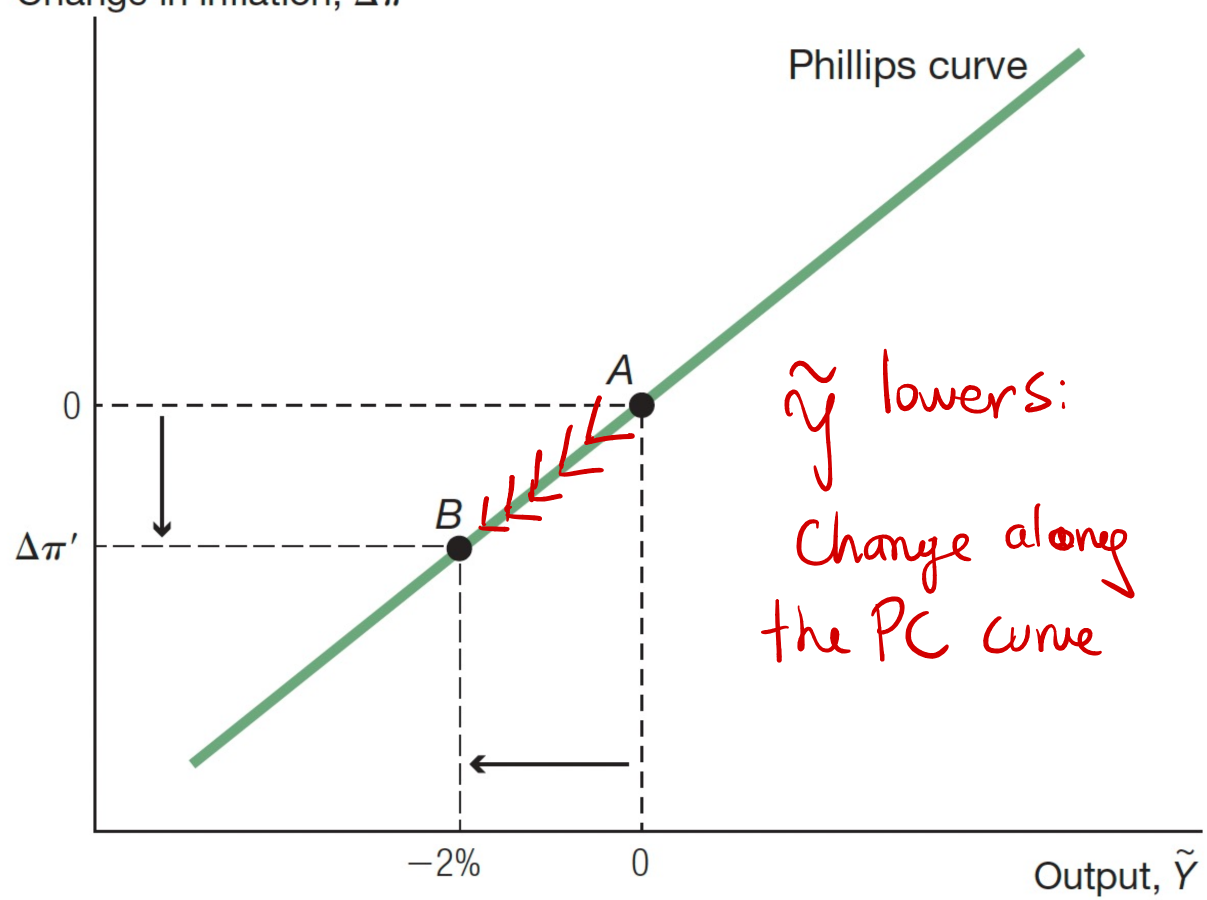
This curve also shows a decrease in inflation

What are we looking at here?

Policy makers trade off (higher) unemployment and (lower) output to lower inflation

Key: Policy tradeoff involved

A Recession and Falling Inflation



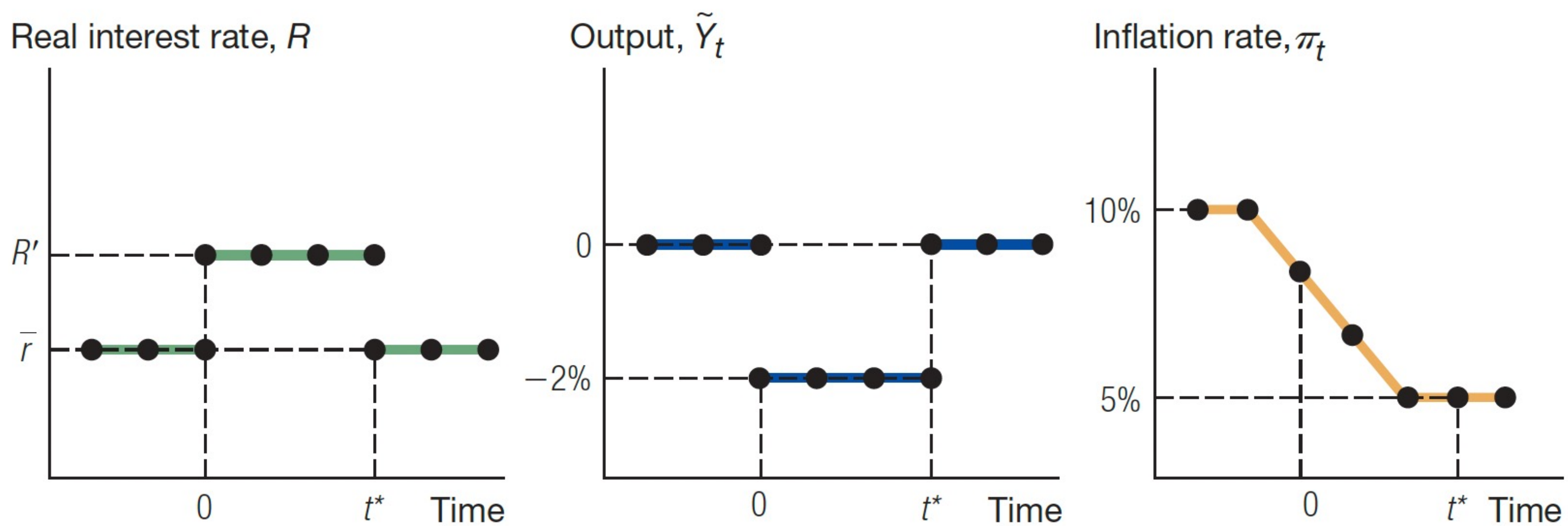
Complementary view: Variables vs. Time → Shows more clearly "Sequence" of changes

The economic variables over time

The plots shown before only tell you some snapshots of the story (initial point and initial effect).

Beyond that, we also can look at how these variables evolve over time

The Disinflation over Time



(a) The Fed raises the interest rate . . .

(b) causing a recession . . .

(c) which leads inflation to fall.

Temporary Increase in int. rates → Effects on output (↓) and via ↓ Demand → Inflation decelerates (Slowly)

Shocks / Drivers of π in 1970's

Causes of inflation of 1970

There were several reasons for inflation rising during this time period:

Oil shock due to OPEC increasing prices $\longrightarrow$ $\uparrow$ Input Prices $\rightarrow$ $\uparrow \bar{\theta}$

Loose monetary policy by the Fed Initial lowering of rates

- Fed was too worried about increasing unemployment
- There was a belief that this increase in unemployment would be permanent

Asymmetric information

- The Fed believed that the economy was in a recession and lowered interest rates
- In reality, there was a decrease in potential output due to a productivity slowdown

Problem: Fed saw $\downarrow Y$ and thought it was because $\downarrow \tilde{Y} \Rightarrow$ Cut Rates

But in reality: $\downarrow \bar{Y}$: Then it was useless to $\downarrow R$

(If something it only added π to the existing unemployment)

Using the Short-run model

Perils of mistaking $\downarrow \bar{Y}$ with $\tilde{Y}$
(given we only observe Y)

How troublesome is mistaking a decrease in potential output for a recession?

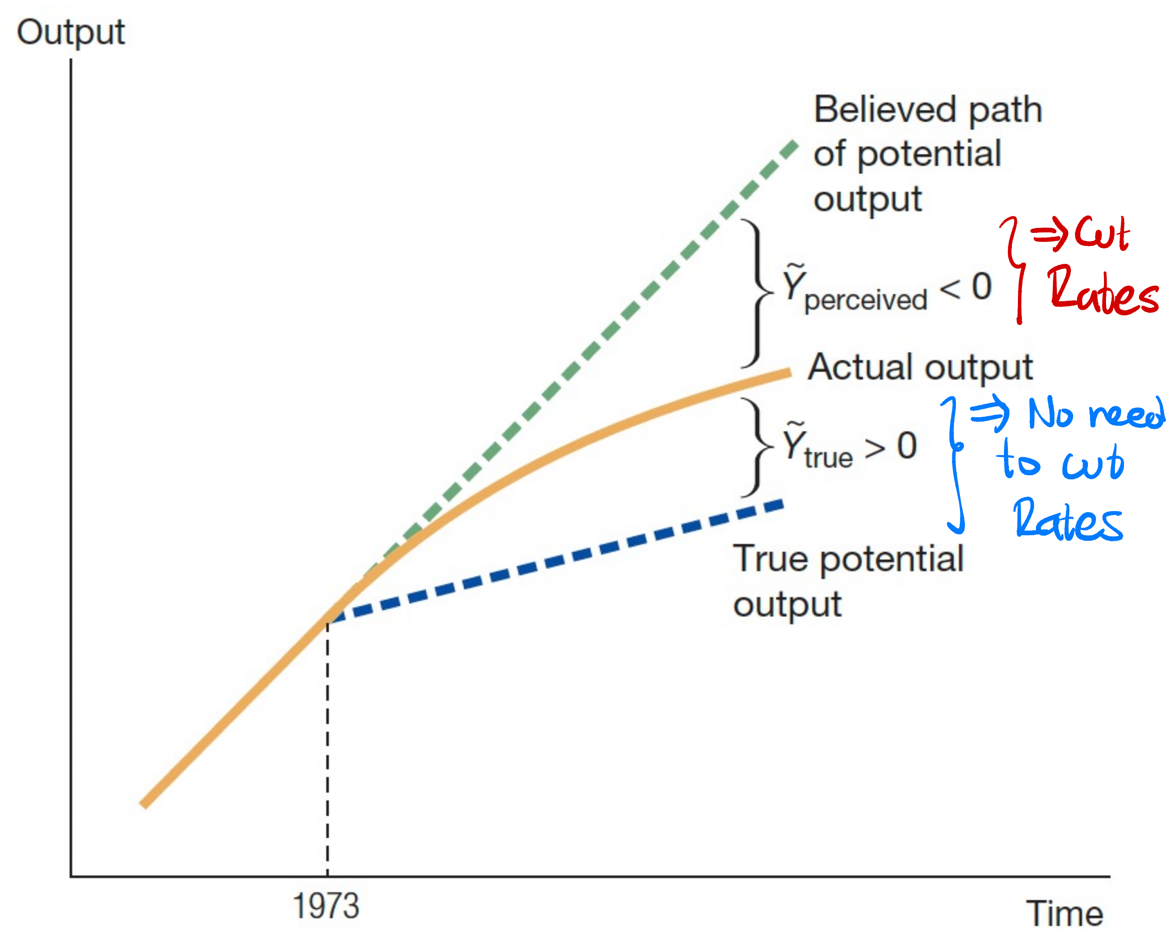
It can make the difference between diagnosing a recession vs. normal times' fluctuations

With a different diagnostic it comes a different policy action:

- Stimulate vs. cool down the economy

→ Different diagnostics
⇒ Different policies

Mistaking a Slowdown in Potential for a Recession



Sticky inflation

Main feature of short-run model:

Sluggish π is what allows Fed to set R (by setting i)

$R = i - \pi$ (Fisher Eq)

The main element of the short-run model is the assumption of **sticky inflation**

In the context of the short-run model:

- Changes in the nominal interest rate affect the real interest rate.

In the context of the classical dichotomy:

- Changes in nominal variables should have only nominal effects

Therefore, if monetary policy affects real variables, the classical dichotomy **fails in the short run**

In long run insted $R \approx \bar{r}$

The only way the classical dichotomy can hold at all points in time is if all prices, including wages and rental prices, adjust in the same proportion immediately

In the background: Central bank controls Money Supply to set an Interest rate

How do central banks set interest rates?

The central bank controls the interest rate by supplying whatever money is demanded at that rate

The **demand for money is downward sloping**

- As the interest rate decreases the demand for money increases
- It is less expensive to hold money, so people hold more money

By committing to supply whatever money is demanded **at any interest rate**, the Fed is basically making the money supply curve horizontal

Shifts in the money demand curve will not change the eventual interest rate

Money Supply: Policy → exogenous
Money Demand: Lowers with Interest Rate

In equilibrium these will dictate the Interest rate

But: key assumption: Fed commits to setting a given rate and will adjust money supply to achieve it regardless of what happens with money demand then it's easier to bypass the money step → instead focus on rates directly

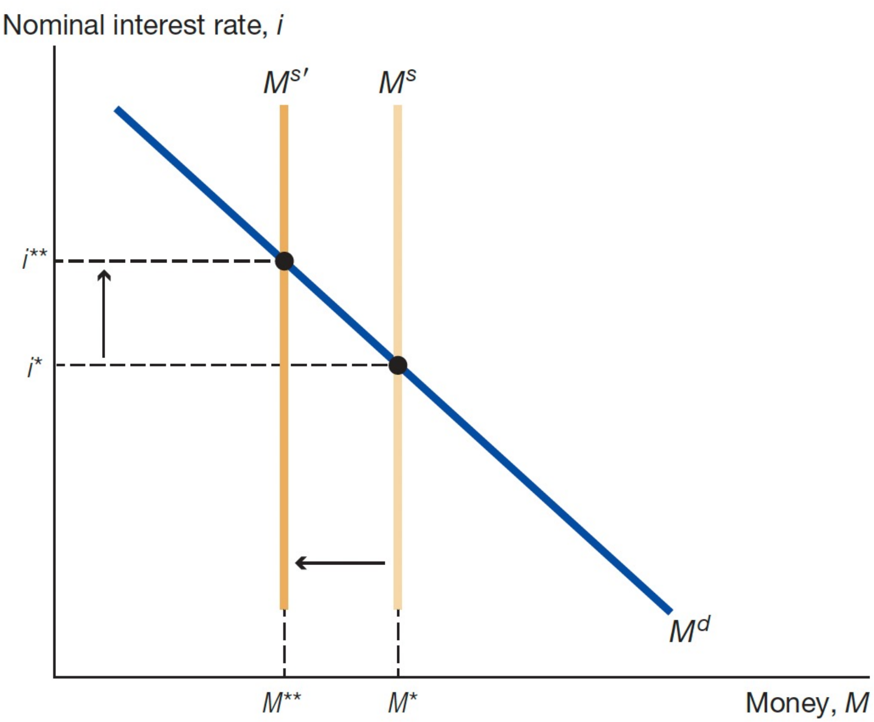
Why don't we use the Money Market plot?

The central bank in reality adjusts the money supply to target a rate. Thus, we could focus on the money market instead.

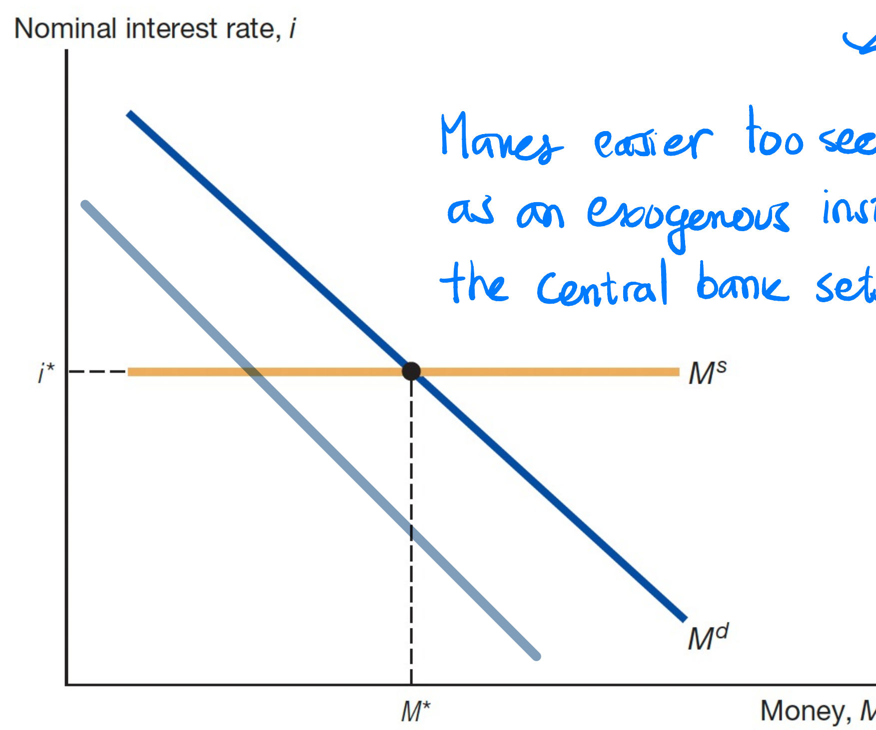
However, the rate resulting there **does change after shocks on the money demand**.

By bypassing the money step (that still occurs in reality) we are stating that the central bank commits to adjust the money supply in a way that the nominal rate is set at a targeted level.

Raising the Nominal Interest Rate



Targeting the Nominal Interest Rate



Makes easier too see rates as an exogenous instrument the central bank sets

Monetary Policy: by setting i (FFR) the central bank changes R

Possible due to: Price Stickyness / Sluggishness of π

Once R changes → (R − MPK) changes ⇒ Investment / Consumption
$(\bar{r})$
Output: Changes

Conclusion

Policymakers **exploit the stickiness of inflation**

- This allows changes in the nominal interest rate to affect the real interest rate
- Allowing them to stimulate or cool down the economy to manage economic (Aggregate Demand) fluctuations

Because inflation evolves gradually, the only way to reduce it is to slow the economy

π reduced by cooling down economy (w/ ↑ R) → Achieved at the cost of ↓ Y

- If this were not the case, the central bank could announce that it was reducing inflation and all firms would adjust immediately

If policymakers can simply change expectations, then inflation can be reduced without large recessions

Mechanism for these policy actions:

Initial policy action

Mechanism:

MP curve	$\uparrow i_t \Rightarrow \uparrow R_t$
IS curve	$\uparrow R_t \Rightarrow \downarrow \tilde{Y}_t$
Phillips curve	$\downarrow \tilde{Y}_t \Rightarrow \downarrow \Delta\pi_t$

Intended policy Outcome

Appendix

Inside the Federal Reserve

Conventional Monetary Policy —Tools of the Federal Reserve:

The Federal Reserve has three main tools for exercising monetary policy:

Fed Funds Rate:

- The primary tool focused on in this lecture.

Our main focus was this policy

Reserve Requirements:

- Banks must hold a certain fraction of their deposits in reserves with the central bank
- Reserves historically paid no interest, but changes occurred during financial crises
- In October 2008, the Fed began paying modest interest on reserves

Discount Rate:

- The interest rate charged by the Fed on loans to commercial banks and other financial institutions
- Acts as lending of last resort
- Tracks the fed funds rate closely

Inside the Federal Reserve(continue)

•**Reserve Requirements**:

- Banks hold reserves to meet requirements set by the central bank.
- Reserves are kept in special accounts with the central bank.

•**Impact of Monetary Policy Tools**:

- The Fed funds market allows banks with excess reserves to lend to those with shortages.
- The Fed funds rate is the interest rate for these transactions.

$\Rightarrow$ FFR is the int. rate set by the Fed as we said
But it is also a type of "Interbank" rate: a rate at which a bank A (e.g. BOA) lends their extra reserves to bank B (e.g. Chase)