

Class 2

Models of short-run fluctuations:
IS-TR(LM), and AS-AD

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What you will get from today class

- Simple model of **short-run** output determination (the Keynesian framework).
 - **Joint equilibrium** of **goods** markets (IS) and **money** market (TR). 
 - Focus on **demand**, holding **prices constant**. 
- **Introducing supply** and **expectations** (aggregate supply AS and aggregate demand AD).
 - Contrast **horizons**: **short** and **long-run**.
 - Prices eventually adjust, **expectations** are key to policy (in)effectiveness.
- Ad-hoc models with no explicit optimization.

A question to start

HIGH π (INFL.) vs RECESSION

1980, By stabilizing economic activity, a central bank can limit inflation fluctuations. It should thus lower interest rates when a recession risk emerges.

UNC. INT. PRIORITY

$i \downarrow \rightarrow \pi + \uparrow$ ZLB $i \geq 0$ $i^{\text{os}} \text{ vs. } i^{\text{LP}}$

CREDIBILITY; QT
(π TARGET) \leftarrow JOB CB

Do you agree? Why or why not?

US: STRONG
DESP. $i \uparrow$

SOURCE \uparrow DEMAND ✓

SUPPLY !

$$P_t = \frac{\text{RENT}}{i}$$

IS – TR FRAMEWORK

FOCUS ON **SHORT** – RUN **DEMAND**

Main features of the IS-TR model

2Q - 4Q

- Focus on **short-run equilibrium**, as models designed to think about the long-run cannot account for the Great Depression.
- The **Keynesian** framework has two main aspects:
 - Expectations are taken as **given**, **prices are preset** ("sticky"). Output is driven by demand (i.e. supply is not binding).
 - **General equilibrium** modeling across the market for **goods** (IS) and the **monetary** side (TR, or LM in earlier variants).
 - How movements in one market are transmitted to the other.
- **Limitation**: supply and expectations are ignored, it's only valid as a short-run model.
- We solve for IS, and then for TR.

The market for goods: consumption and investment

- Ad-hoc reasonable rules of behavior (but no explicit optimization).
 - We consider linear relations (or linear approximation around a steady state).

- Consumption C is an increasing function of the income after tax ($Y - T$) and other factors shifting consumption such as (Ω , wealth, confidence) :

"ANIMAL SPIRITS" $C = c_1(Y - T) + c_2\Omega$

- Investment I is increasing in firms' expectations of profitability (Q) and decreasing in the real interest rate (the interest rate i minus expected inflation π^e):

$$I = -i_1(i - \pi^e) + i_2 Q$$

Equilibrium: the IS curve

- Total expenditure consists of consumption, investment and **exogenous government spending (G)**. In equilibrium expenditure is equal to GDP:

$$Y = C + I + G$$

- **GDP** is thus given by an **endogenous variable (i)** and a set of exogenous variables (π^e , G , T , Ω , Q):

$$Y = -\frac{i_1}{1 - c_1} (i) + \pi^e + \frac{G - c_1 T}{1 - c_1} + \frac{c_2}{1 - c_1} \Omega + \frac{i_2}{1 - c_1} Q$$

- The impact of an exogenous variables, say G , on output is magnified by a factor $1/(1 - c_1)$. This is the **multiplier**.
 - Higher government spending directly raises output and income.
 - Higher income then raises consumption, an indirect effect of the higher government spending.

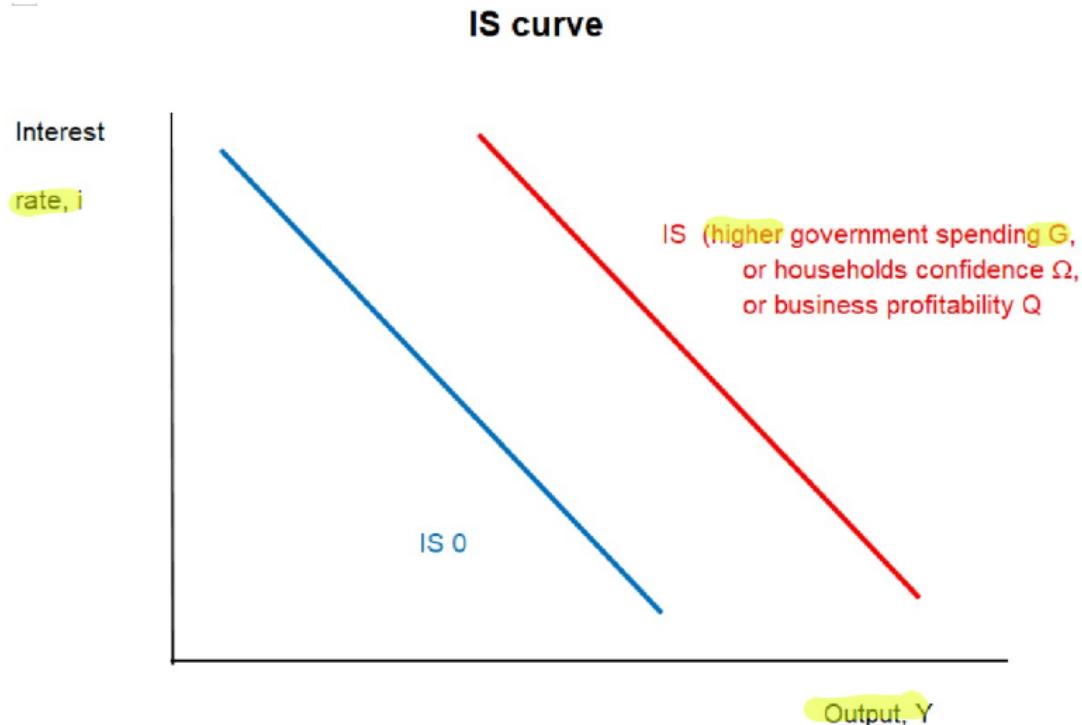
Move along the IS curve vs. shift of the IS curve

ENDOGENOUS

- IS curve: a negative relation between output Y and the interest rate i , given exogenous variables (say G).
 - Changes in exogenous variables shift the IS curve in the $Y - i$ space.
- Do not confuse a **move along** the IS curve and a **shift of** the curve itself.
 - Move along**: different combinations of Y and i given G, T, π^e, Ω, Q .
 - Shift of**: change in G, T, π^e, Ω, Q affecting Y for a given i (and i for a given Y).
- Effect of a **shift** (higher G): think horizontally (what happens to Y if we keep i unchanged) and vertically (what happens to i if we keep Y unchanged). ► tracing IS shift

Drawing the IS curve

- Negative relation between Y and i .



The monetary side

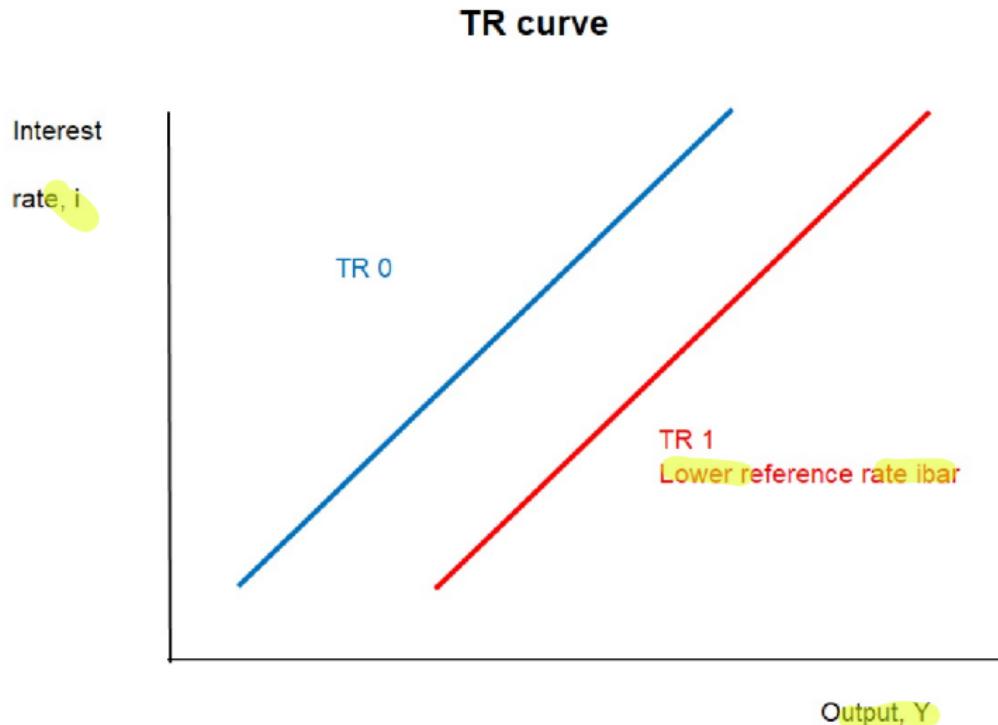
- The central bank sets the nominal interest rate as a function of a target value \bar{i} , inflation π , and the output gap (the deviation of GDP from a target \bar{Y}): $i = \bar{i} + a\pi + b(Y - \bar{Y})$

$$i - \bar{i} = a\pi + b(Y - \bar{Y})$$

- TR (Taylor rule) curve: positive relation between output and the interest rate. i reflect the stance of monetary policy given output and inflation.
- Do not confuse a move along the TR curve and a shift of the curve itself.
 - Move along: different combinations of Y and i given \bar{i} .
 - Shift of: change in \bar{i} affecting Y for a given i (and i for a given Y).
- Effect of a shift (lower \bar{i}): think horizontally (what happens to Y if we keep i unchanged) and vertically (what happens to i if we keep Y unchanged). [tracing TR shift](#)
- Earlier representations considered a money demand (LM) instead of TR, but same message. [LM line](#)

Drawing the TR curve

- Positive relation between Y and i .



IS-TR equilibrium

- Both **the goods** and **asset markets** **clear**. IS and TR give a system of two equations in two endogenous variables (Y and i):

$$\begin{array}{ll} \text{IS} & Y = -\frac{i_1}{1-c_1}(i - \pi^e) + \frac{G - c_1 T}{1-c_1} + \frac{c_2}{1-c_1}\Omega + \frac{i_2}{1-c_1}Q \\ \text{TR} & i = \bar{i} + a\pi + b(Y - \bar{Y}) \end{array}$$

- The solution of the system is:

$$\begin{array}{ll} Y & = i_1\Gamma_1 + \Gamma_2 \\ i & = (1 - c_1)\Gamma_1 + b\Gamma_2 \end{array}$$

- where Γ_1 and Γ_2 regroup exogenous variables related to TR and IS:

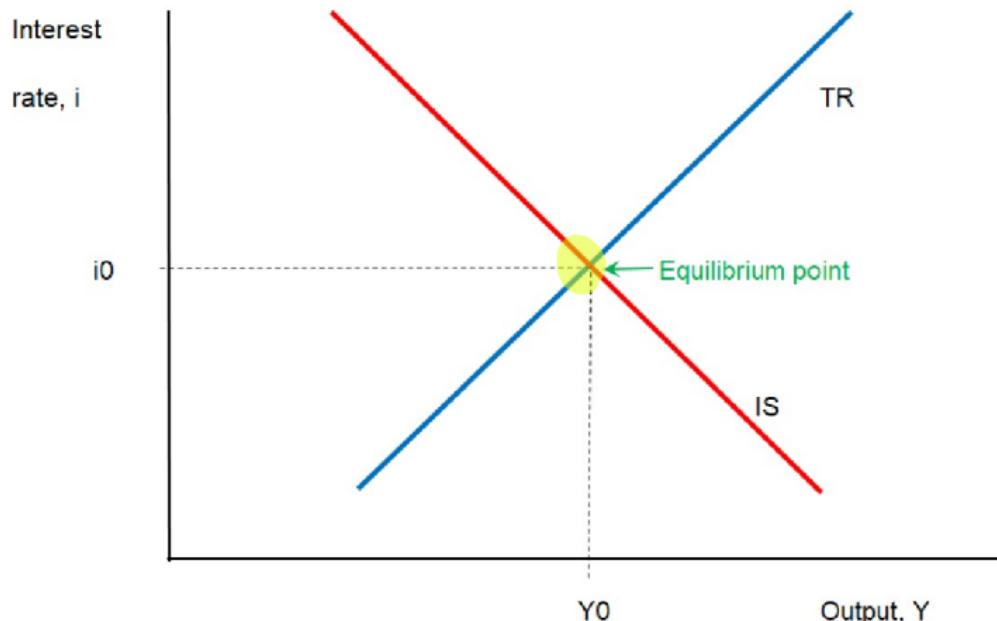
$$\Gamma_1 = \frac{1}{1 - c_1 + bi_1} [\bar{i} + a\pi - b\bar{Y}]$$

$$\Gamma_2 = \frac{1}{1 - c_1 + bi_1} [i_1\pi^e + G - c_1 T + c_2\Omega + i_2 Q]$$

Graphical representations

- Equilibrium in **both** the market for good and the money market.

IS-TR equilibrium



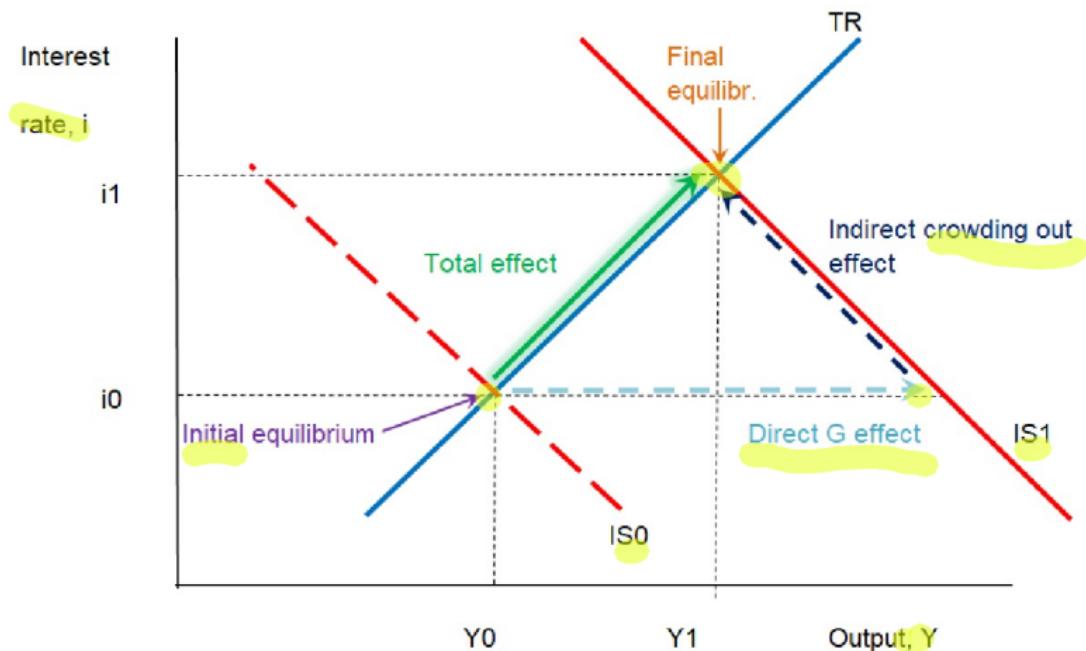
LET'S DO SOME POLICY

- An increase in G shifts IS to the right: given i , Y is higher. TR is unaffected. The result is a higher output and higher interest rate.
 - Direct effect: boost output (shift of IS). MULTIPLIER
 - Higher output leads to a higher interest rate from the Taylor rule (move up along TR).
 - Higher interest rate reduces investment and dampens the initial increase in output: crowding out effect.
- An increase in consumers' wealth Ω , in firms' expectations Q , or in inflation expectations π^e has the same effect.

Graphical representation of fiscal expansion

- Higher government spending G raises Y and i .

Higher government spending

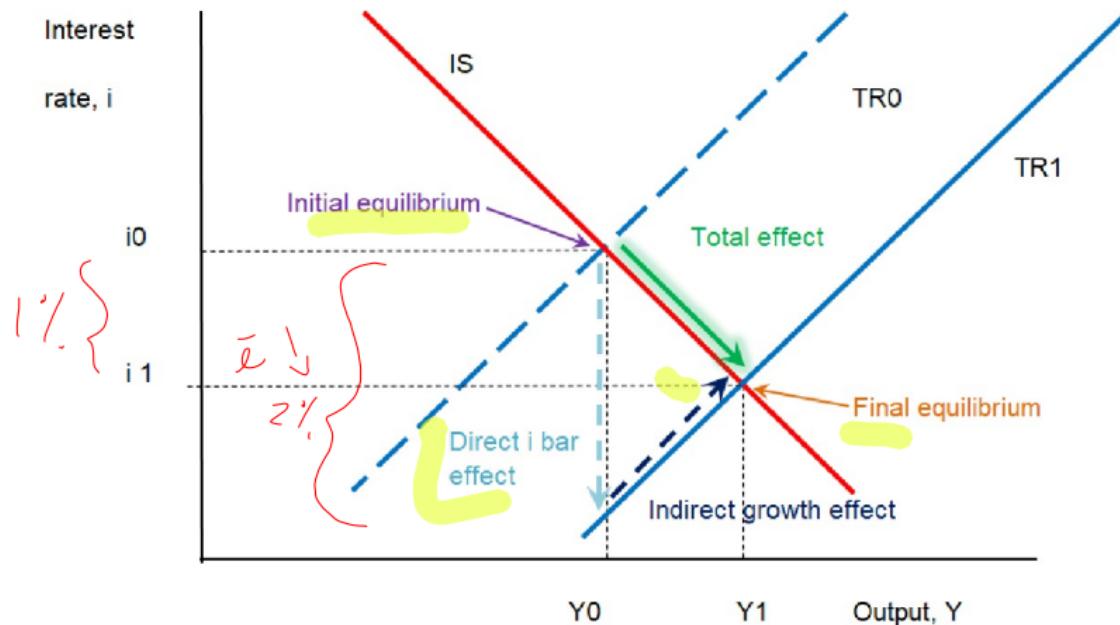


- Reduction in the target rate \bar{i} shifts TR to the right: given i , Y is higher. IS is unaffected. The result is a higher output and lower interest rate.
 - Lower target \bar{i} reduces the interest rate for a given output (shift of TR).
 - Lower interest rate raises investment (move down along IS). Output is higher.
 - Higher output leads to an increase in the interest rate through the Taylor rule and dampens the initial reduction in i .
- A reduction in inflation π , or an increase in the reference output \bar{Y} has the same effect.

Graphical representation of monetary expansion

- Lower target rate \bar{i} raises Y and reduces i .

Lower reference interest rate



When is policy (in)effective?

- The output impact depends on the sensitivity of the demands for goods and money to movements in interest rates.
- If interest rates have a big impact on the demand for goods (IS is flat), monetary policy is very effective (i.e. large effect on output), but fiscal policy is not.
- If interest rates have a big impact on the demand for money (TR is flat), monetary policy is not effective, but fiscal policy is effective.
 - A flat TR is referred to as a liquidity trap. Policy acting on the demand for goods are most effective.
 - Government stimulus, generating inflation expectations (forward guidance).

INTRODUCING SUPPLY

From IS-TR to aggregate demand

- The **output solution** in IS-TR gives a negative relation between output and inflation:

$$Y = -\frac{a_i}{1 - c_1 + b_i} \pi + \text{other terms}$$

$\bar{\pi}, G$

- Intuition: higher inflation shifts the TR curve upwards (a contraction of monetary policy), thereby reducing output. ► constructing AD
- This negative relation is the **aggregate demand (AD)** line. It is shifted by policy.
 - Expansionary fiscal policy (**higher G**) moves AD to the right. ► shifting AD
 - Expansionary monetary policy (**lower $\bar{\pi}$**) also does that.

Aggregate supply: the long-run

AS captures the supply-side, and its properties are dependent on the horizon considered.

LR: AS \rightarrow quantity

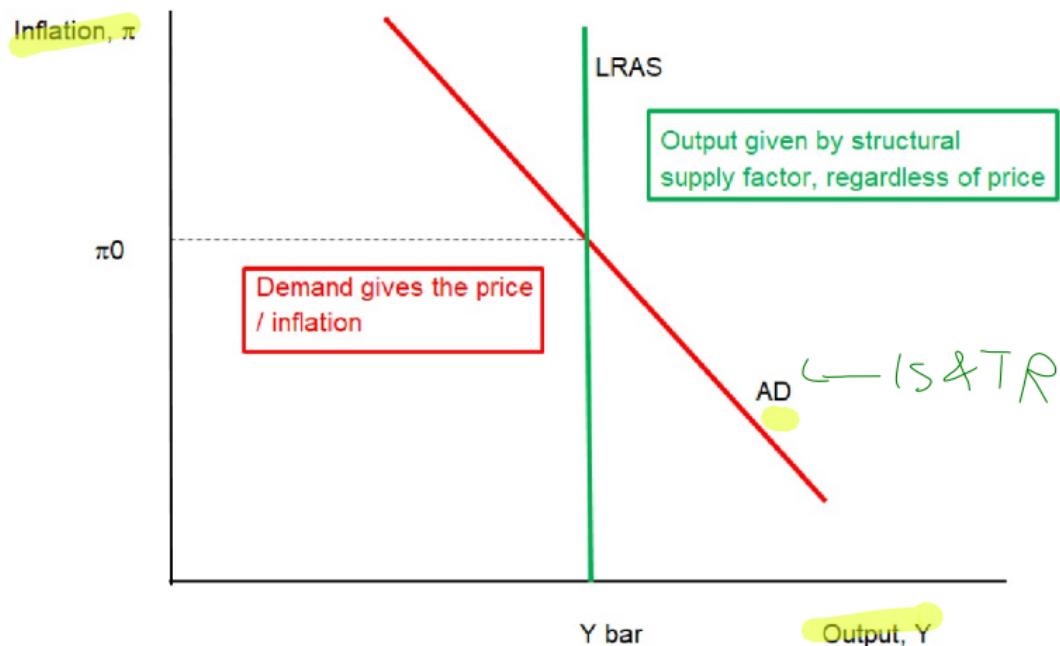
AD \rightarrow π

- AS captures the **supply-side**, and its properties are dependent on the **horizon** considered. P ADJUSTED
- Long-run, capital and labor are set by the **structure** of the economy (productivity, structure of the labor market).
 - Intersection of **labor supply** and **labor demand** determines employment. There is no involuntary unemployment (i.e. labor supply does not exceed labor demand at prevailing wages).
 - Prices are **fully flexible**.
- Output is set at some fixed level \bar{Y} , the **natural rate**, and AS is vertical.
- Inflation is determined by the intersection of AD and AS.

Long run equilibrium

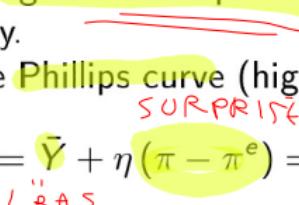
- Supply (LRAS) gives the quantity, demand (AD) gives the inflation.

AD - AS in the long run



Aggregate supply: the short-run

- In the short run AS (SRAS) has a **positive slope**. This reflects inertia in the adjustment of prices.

- **Prices** (inflation) are the signal for firms to produce **more** or less (more specifics in the short problems).
 - If inflation is **higher than expected**, profitability is high and firms increase supply.
 - Related to the **Phillips curve** (high inflation = low unemployment):


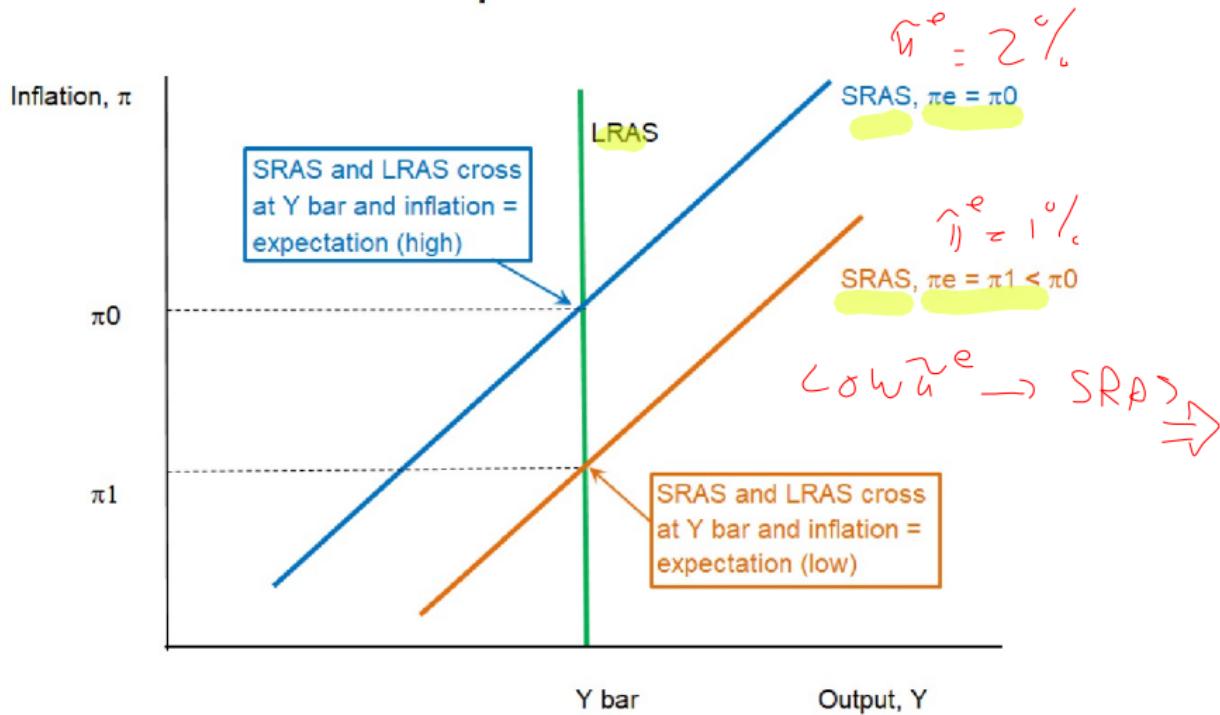
$$Y = \bar{Y} + \eta(\pi - \pi^e) \Rightarrow \pi = \pi^e + (1/\eta)(Y - \bar{Y})$$

- Key role of **inflation expectations** π^e . **Given** π^e we have a positive relation between output and inflation (short-run AS).
- **Higher π^e shift the curve up** (higher π for a given Y). When inflation is as expected ($\pi = \pi^e$), the output is at the long run level, $Y = \bar{Y}$.

Impact of expectations on SRAS

- Higher inflation expectations move the curve up.

Lower expected inflation



How expectations are formed

- **Adaptive expectations**: agents look at the past to learn about the future, correcting for mistakes. **Ad-hoc rules**, for instance:

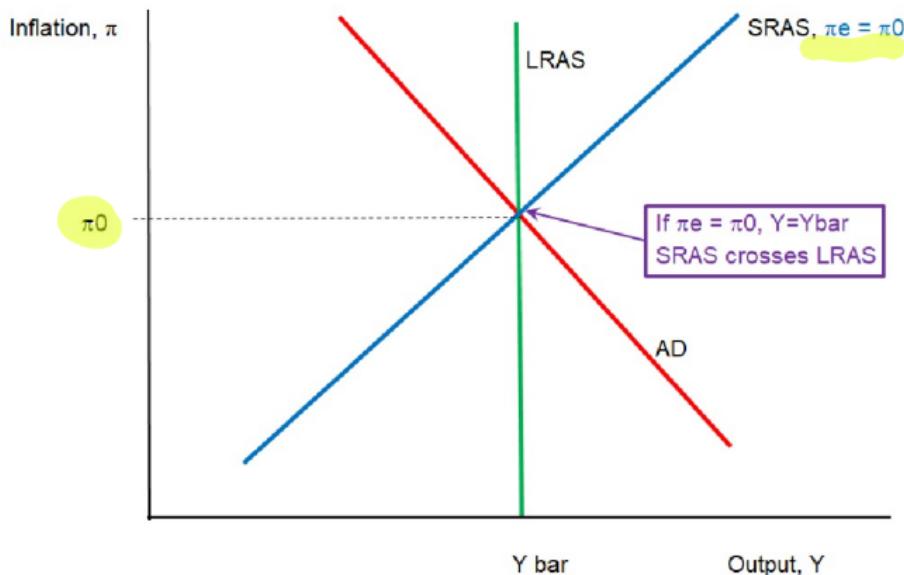
$$\pi_t^e = \pi_{t-1} \quad \text{or} \quad \pi_t^e = \pi_{t-1}^e + \varsigma (\pi_{t-1} - \pi_{t-1}^e)$$

- **Rational expectations**: agents understand the model and work it out. They are only surprised by unexpected shocks, not by systematic policy.
- **Learning**: agents are uncertain about the model and figure it out through regressions. Gives a **backward-looking** dimension to expectations.
- The environment can matter: in times of hyperinflation it pays to figure out what the central bank is doing, while in normal time a more inertial rule is "good enough".

Overall system

- In the long run all lines cross. LRAS gives quantity, AD gives inflation, and SRAS matches them as inflation matches expectations.
- In the short run, SRAS and AD gives the equilibrium, can be off LRAS.

Overall system in long run



EFFECT OF SUPPLY SHOCK

A permanent AS shock

- We leave the effect of a shock to AD as an exercise.
- A **permanent shock to supply** leads to **equal shifts** in both the long-run (LRAS) and short-run (SRAS) supply curves.
- Reduction of long-run output by $\eta\xi$ to a new natural output $\bar{Y}_{\text{new}} = \bar{Y}_{\text{old}} - \eta\xi$. The short-run AS becomes

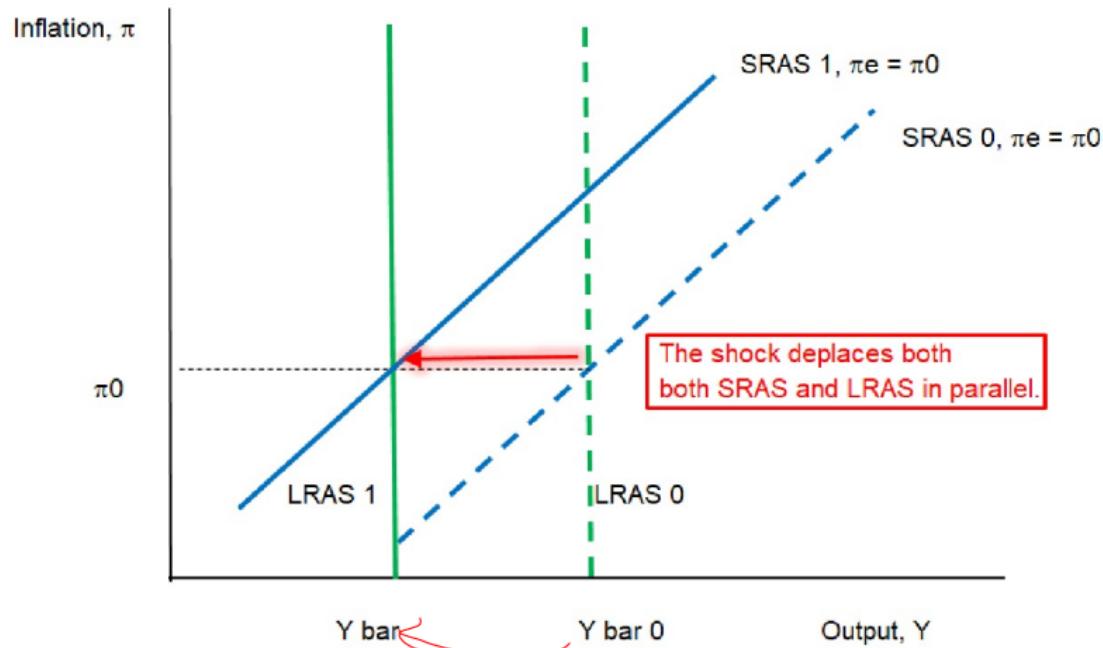
$$\pi = \pi^e + \frac{1}{\eta} (Y - \bar{Y}_{\text{new}}) = \pi^e + \frac{1}{\eta} (Y - \bar{Y}_{\text{old}}) + \xi$$

- The adjustment depends on the **reaction of AD**. We first consider that **policy remains passive**.
- **Inflation increases** and **output decreases**. The speed of the move depends on the nature of expectations (adaptive or rational).

Graphical representation of supply shock

- The shock moves both supply curves.

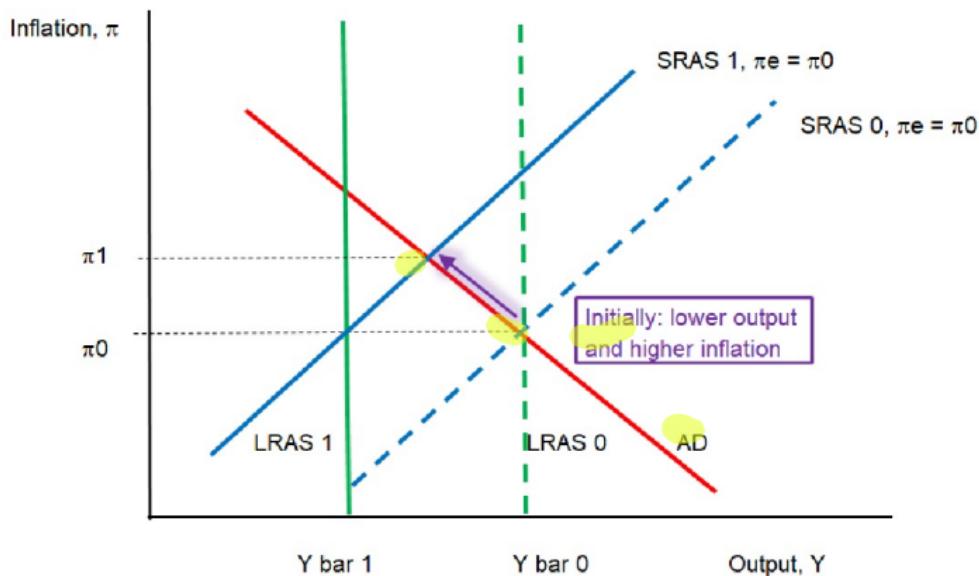
AS shock



Passive policy: initial adjustment

- Initially output decrease and inflation increase, expectations have not yet moved.

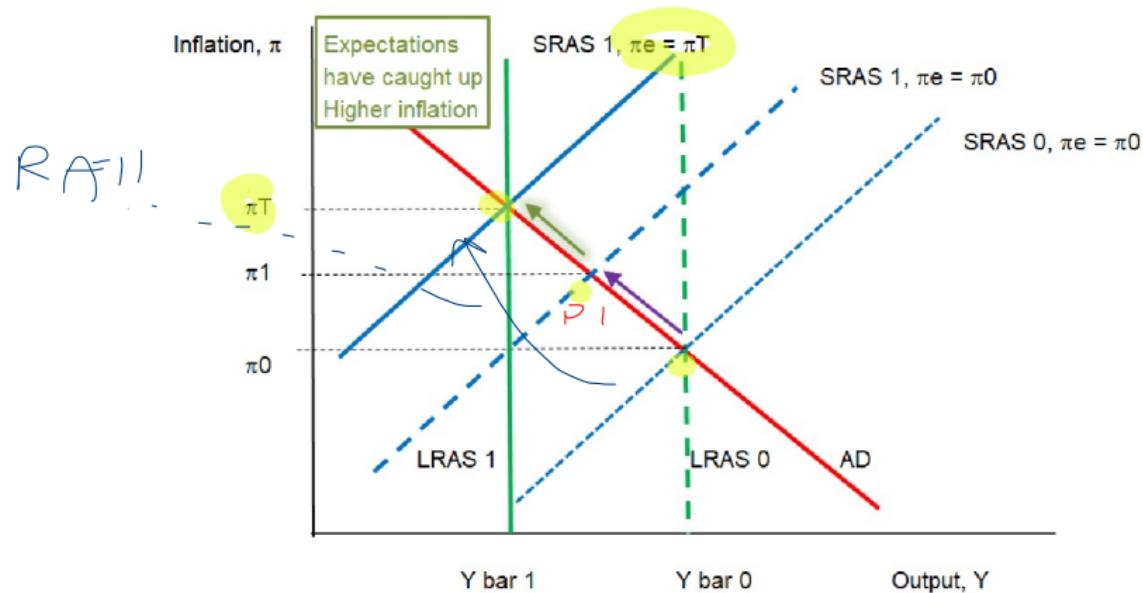
AS shock, no policy reaction



Passive policy: ultimate adjustment

- Ultimately inflation **expectations catch up**, we get lower output and higher inflation.

AS shock, no policy reaction



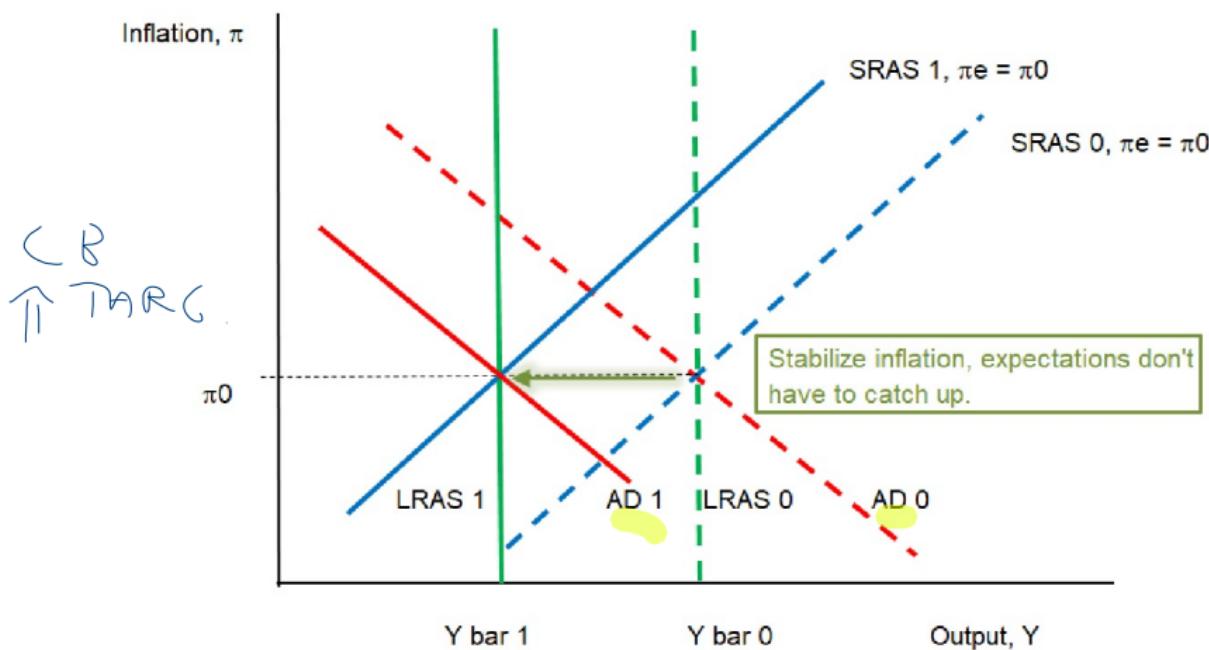
Two alternative policy responses

- **Accept the new reality:** the policy **recognizes** that the structure of the economy has changed.
 - **Output will decrease**, so the policy can at least **avoid inflation**.
 - **Contractionary policy** moving AD to the left to the new long run output level.
- **Rearguard battle:** policy **fights the shock** to delay the decrease in output.
 - Expansionary policy in the short run moving **AD to the right**.
 - Ultimately this **only fuels inflation**.

Accept (unpleasant) reality

- Contractionary policy at the time of the shock, stabilizes inflation.

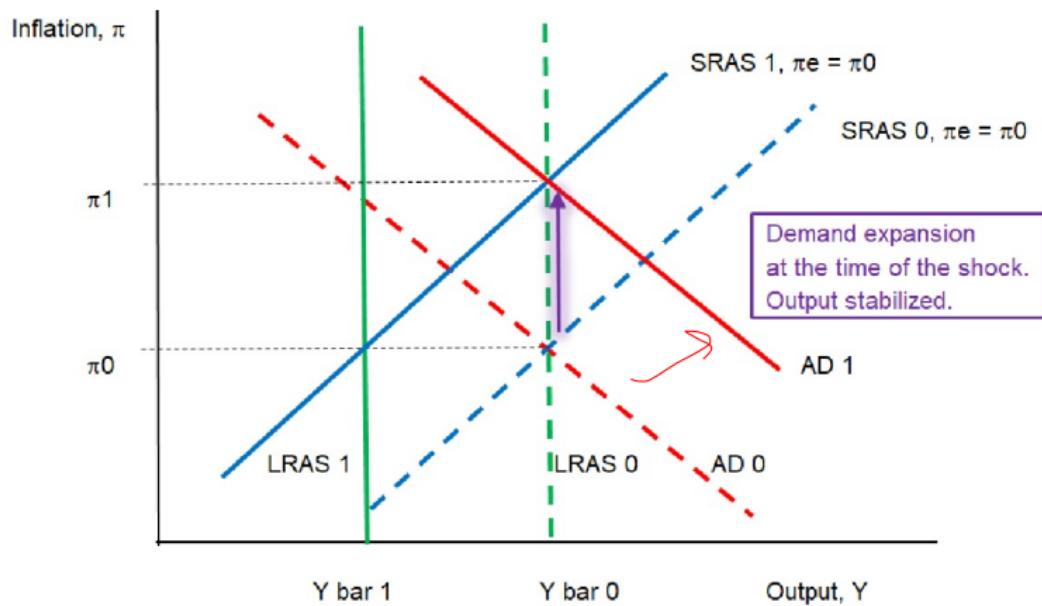
AS shock, inflation stabilization



Denial: initial adjustment

- 170
- Expansionary policy at the time of the shock, output stabilization. Expectations have not yet moved.

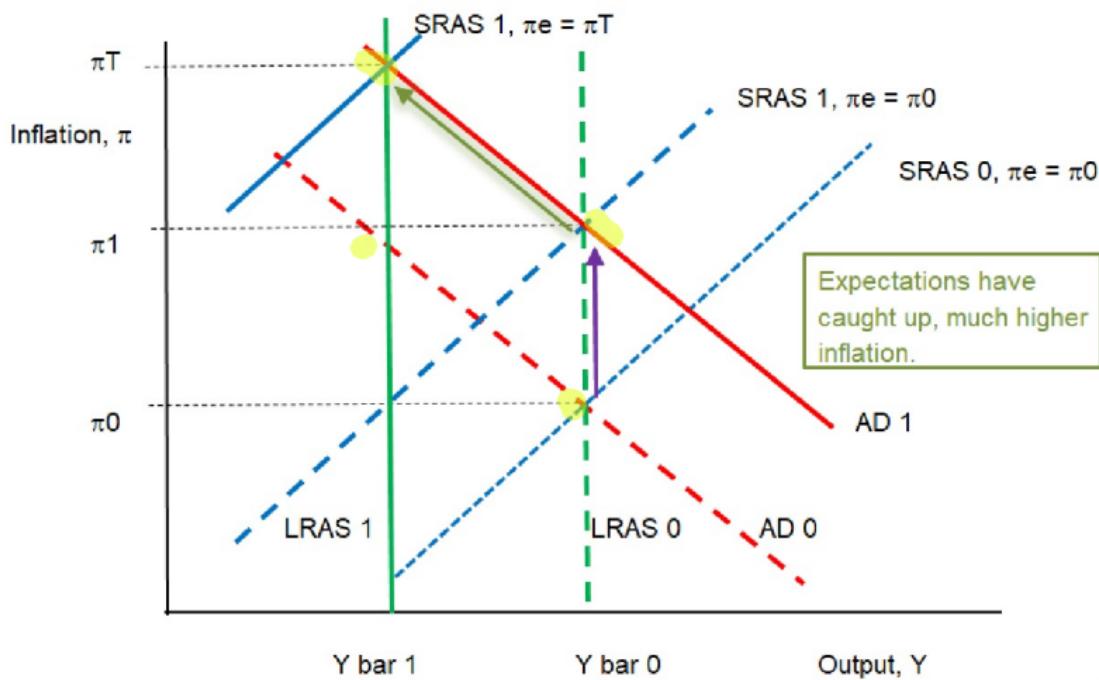
AS shock, temporary output stabilization



Denial: ultimate adjustment

- Ultimately inflation expectations catch up, we get higher inflation.

AS shock, temporary output stabilization

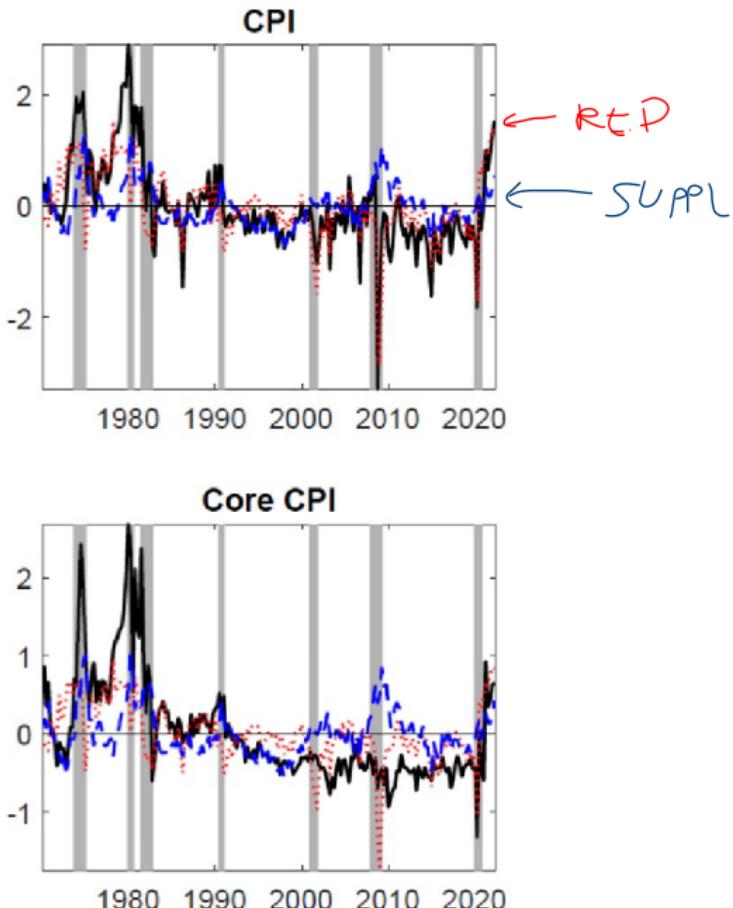


- **Backward looking expectations** (π_t^e depends on π_{t-1}): systematic increases in inflation can bring unemployment down, as agents are repetitively surprised.
- **Rational expectations**: agents cannot be surprised repetitively and realize that the monetary authorities are generating inflation. Include this behavior in expectations ($\pi_t^e = \pi_t$).
- Random movements in AD give a positive correlation between inflation and output. A policy maker could be tempted to exploit this trade-off.
 - Agents however understand and adjust their expectations (short run AS shifts). In the end we get no extra output and only inflation.
- **Lucas critique**: expectations cannot be taken as given by the policy maker. Instead include endogenous expectations in the analysis, don't just rely on reduced-form results.

Some empirical evidence

- Is the recent inflation increase due to **supply or demand** shocks?
 - Identify broad driving sources of inflation in **US and Euro area** (Eickmeier, Sandra, and Boris Hofmann 2022, "What drives inflation? Disentangling demand and supply factors", BIS working paper 1047).
- Broad **range of inflation** and **real activity indicators** (140 quarterly since 1970), **extract supply and demand factors**.
 - **Sign** restrictions: the demand factor raises both inflation and real activity, the supply factor raises activity and reduces inflation.
- During 2008 crisis, both demand and supply went down with offsetting effects on inflation.
- Since Covid, **demand was very positive** and **supply very negative**, both driving inflation.
- Recent inflation in the **US** primarily **demand driven** (but not only). Larger role for **supply** since 2021 in 4 **Euro area** countries than in the US.

- Recent inflation in the US primarily demand driven (but not only). Black: demeaned time series estimates. Red: demand driven. Blue: supply driven.

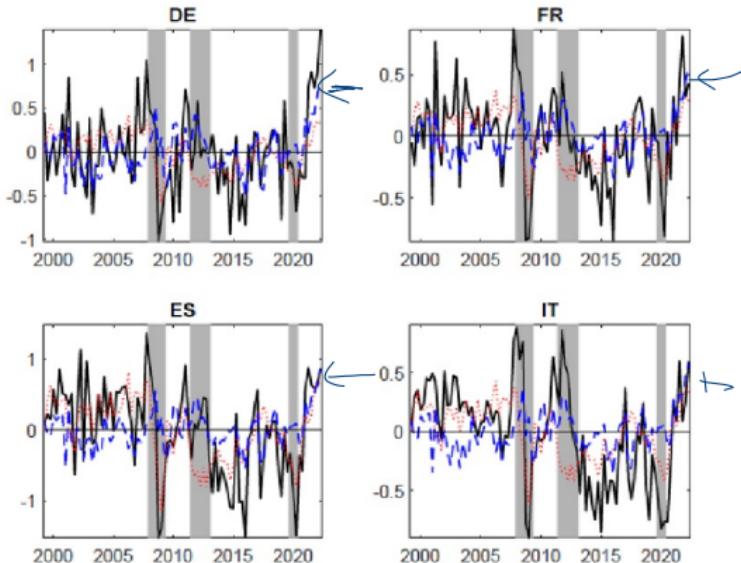


Notes: Quarter-on-quarter, in %. Black: demeaned time series estimates. Red: contributions of the Median Target demand factor. Blue: contributions of the Median Target supply factor. Grey bars: NBER recessions.

Eickmeier, Sandra, and Boris Hofmann (2022). "What drives inflation? Disentangling demand and supply factors", BIS working paper 1047. |

Euro area estimates

- Larger role for supply since 2021 than in the US. Black: demeaned time series estimates. Red: demand driven. **Blue: supply driven.**



Notes: Quarter-on-quarter, in %. Black: de-meaned time series estimates. Red: contribution of the median target demand factor. Blue: contribution of the median target supply factor. Grey bars: CEPR recessions.

[Eickmeier, Sandra, and Boris Hofmann \(2022\). "What drives inflation? Disentangling demand and supply factors", BIS working paper 1047.](#)

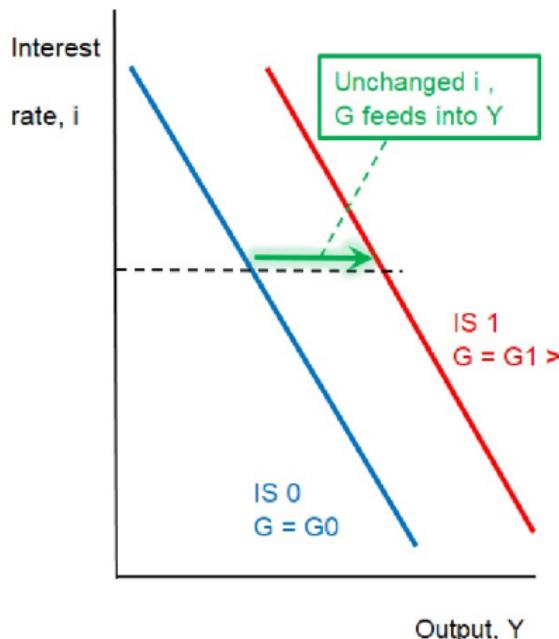
ADDITIONAL SLIDES

Shift of IS

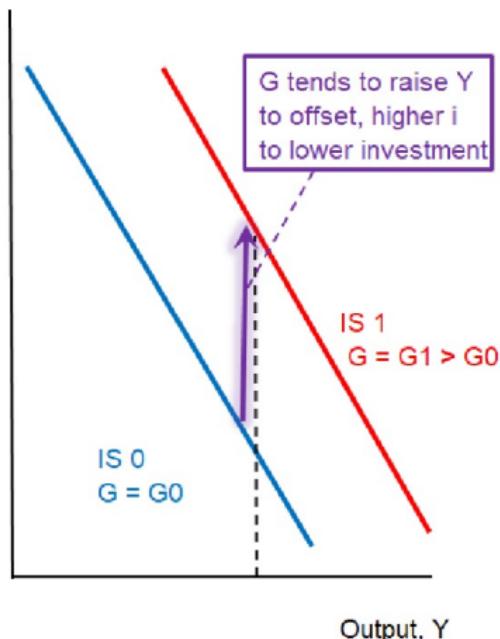
- Effect of higher government spending G .

[◀ Return](#)

Higher G : thinking horizontally



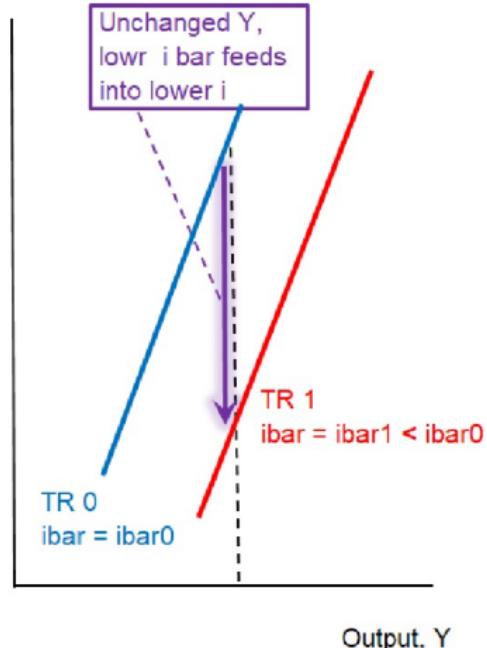
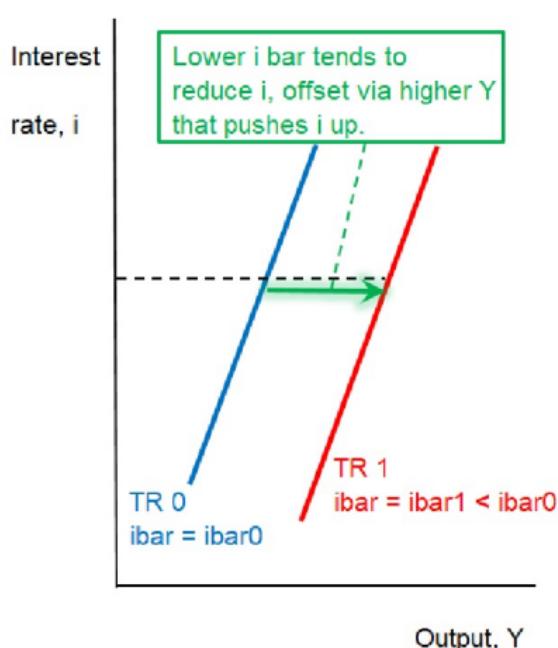
Higher G : thinking vertically



Shift of TR

- Effect of lower target rate \bar{i} . ◀ Return

Lower i bar: thinking horizontally **Lower i bar: thinking vertically**



Relation with monetary aggregates

- In earlier versions of the model, the TR line is replaced by the **demand for money** (the LM relation).
- The demand for **real balances** (money scaled by the price level, $M - P$), is positively affected by output (more transactions require more cash), and negatively affected by the nominal interest rate (a high interest rate make bonds more attractive than cash):

$$M - P = I_1 Y - I_2 i$$

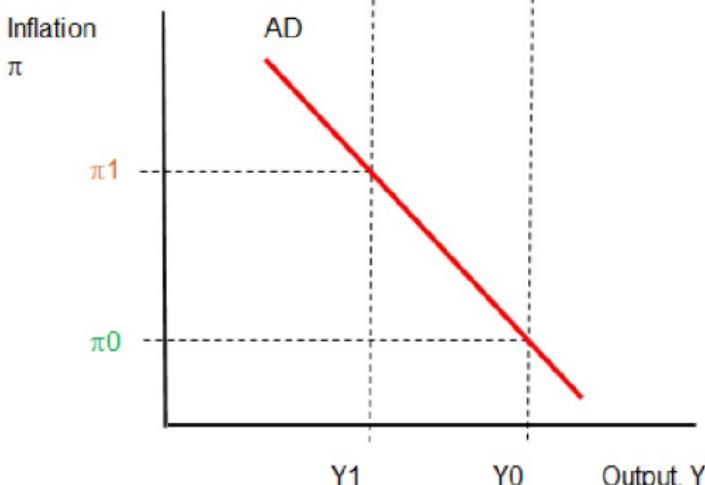
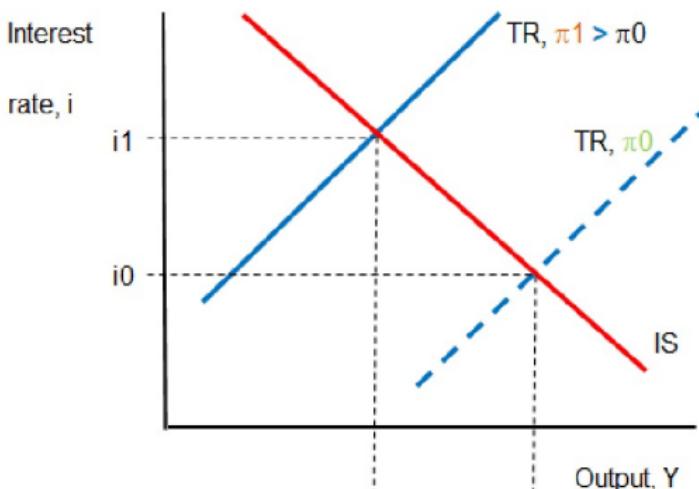
- LM curve: positive relation between output and the interest rate.
- Given real balances a higher output (which raises money demand) must be offset by a higher interest rate (which reduces it).
- One can infer the money holdings from the TR curve and the money demand (see the BW textbook).

[◀ Return](#)

- From IS-TR to AD: two values of inflation.

◀ Return

IS-TR and AD



- Expansionary fiscal policy.

[◀ Return](#)

Fiscal expansion

