Macroeconomics A; EI056

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.

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

Do you agree? Why or why not?

IS − TR FRAMEWORK

FOCUS ON SHORT − RUN DEMAND

Main features of the IS-TR model

- 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.

- 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) :
$$C = c_1 (Y - T) + c_2 \Omega$$
- **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):
$$I = -i_1 (i - \pi^e) + i_2 Q$$

- 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.
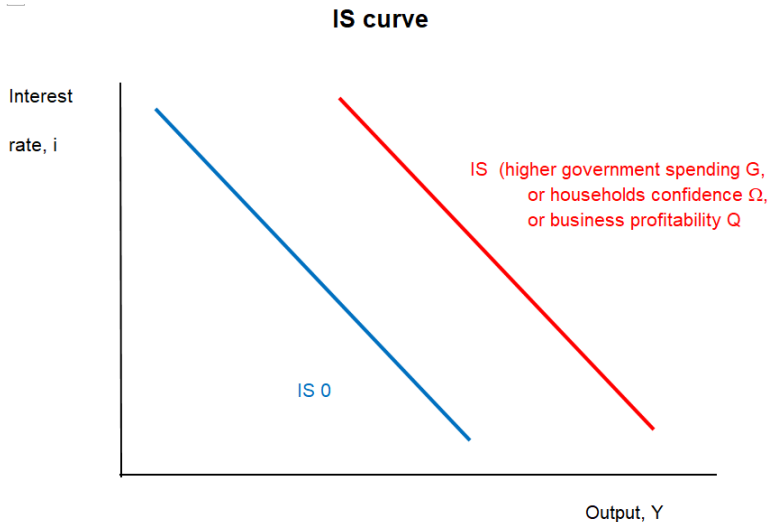
- IS curve: a negative relation between output Y and the interest rate i, **given** exogenous variables (say G).
  - Changes in exogenous variables shift the IS curve in the $Y - i$ space.
- Do not to confuse a **move along** the IS curve and a **shift of** the curve itself.
  - Move **along**: different 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.

IS curve

Interest rate, i

IS (higher government spending G, or households confidence Ω, or business profitability Q

IS 0

Output, Y

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

- TR (**Taylor rule**) curve: positive relation between output and the interest rate. $\bar{\imath}$ 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 $\bar{\imath}$.
  - Shift of: change in $\bar{\imath}$ affecting Y for a given i (and i for a given Y).

- Effect of a shift (lower $\bar{\imath}$): 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.

TR curve

Interest rate, i

TR 0

TR 1
Lower reference rate ibar

Output, Y
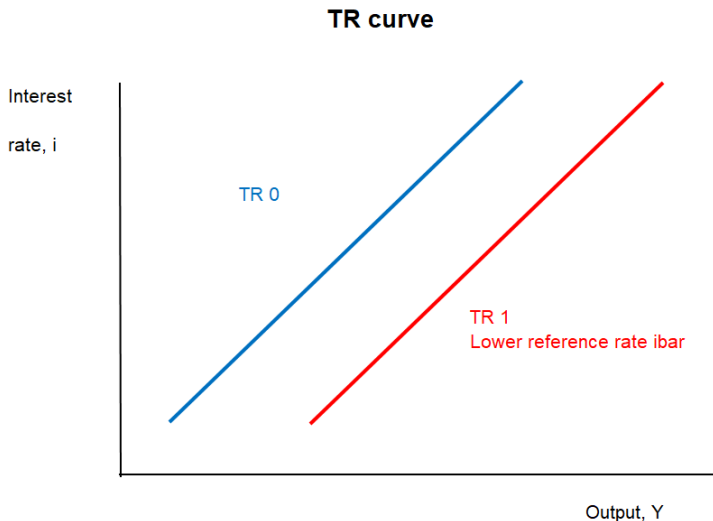
IS-TR equilibrium

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

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

- The solution of the system is:

$$Y = -i_1\Gamma_1 + \Gamma_2$$
$$i = (1 - c_1)\Gamma_1 + b\Gamma_2$$

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

$$\Gamma_1 = \frac{1}{1 - c_1 + bi_1}\left[\bar{\imath} + a\pi - b\bar{Y}\right]$$
$$\Gamma_2 = \frac{1}{1 - c_1 + bi_1}\left[i_1\pi^e + G - c_1 T + c_2\Omega + i_2 Q\right]$$

Graphical representations

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

IS-TR equilibrium

LET'S DO SOME POLICY

Fiscal policy expansion
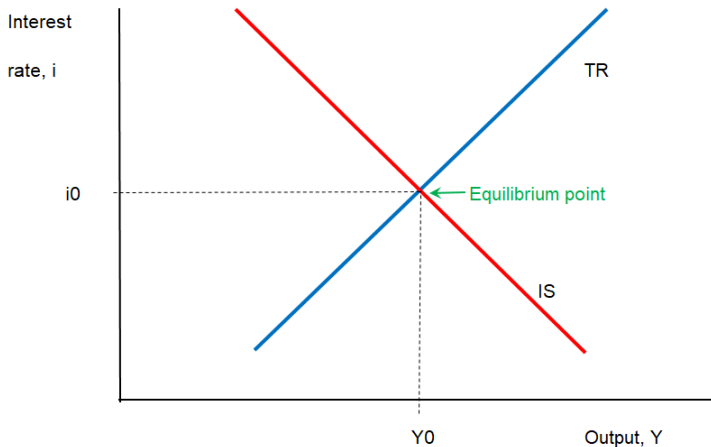
- An increase in G shifts **IS to the right**: given i, Y is higher. TR is unaffected. The result is a higher output and higher interest rate.
  - Direct effect: boost output (shift of IS).
  - Higher output leads to a higher interest rate from the Taylor rule (move up along TR).
  - Higher interest 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

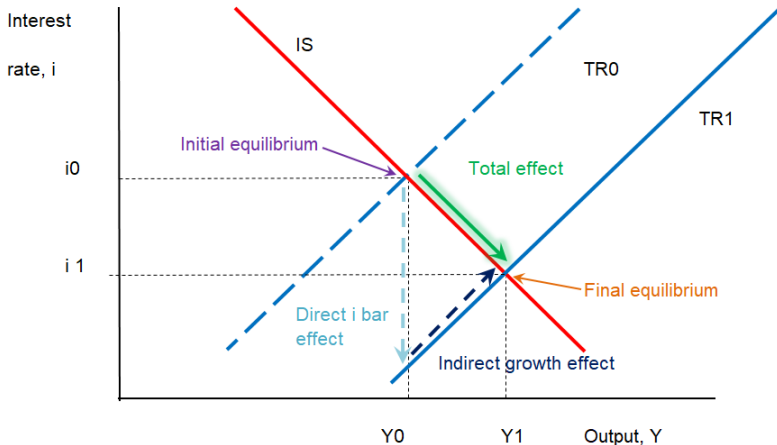- Higher government spending G raises Y and i.

Higher government spending
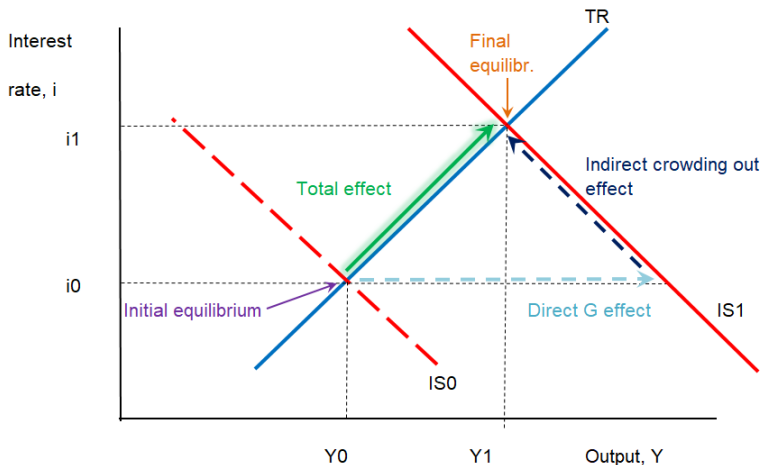
- Reduction in the target rate $\bar{\imath}$ shifts **TR to the right**: given i, Y is higher. IS is unaffected. The result is a higher output and lower interest rate.
  - Lower target $\bar{\imath}$ reduces the interest rate for a given output (shift of TR).
  - Lower interest rate raises investment (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.
- An reduction in inflation π, or a increase in the reference output $\bar{Y}$ has the same effect.

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

Lower reference interest rate

- 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:

$$Y = -\frac{ai_1}{1 - c_1 + bi_1}\pi + \text{other terms}$$

- 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 $\bar{\imath}$) also does that.

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

- Supply (LRAS) gives the quantity, demand (AD) gives the inflation.
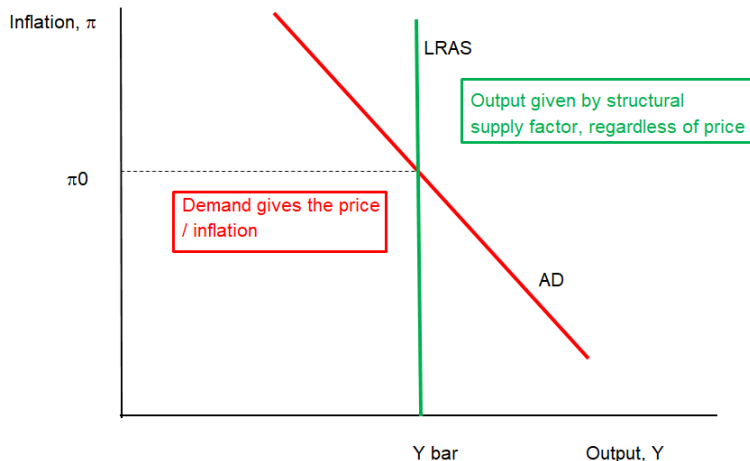
AD - AS in the long run

- 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):

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

- 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, $Y = \bar{Y}$.

- Higher inflation expectations move the curve up.

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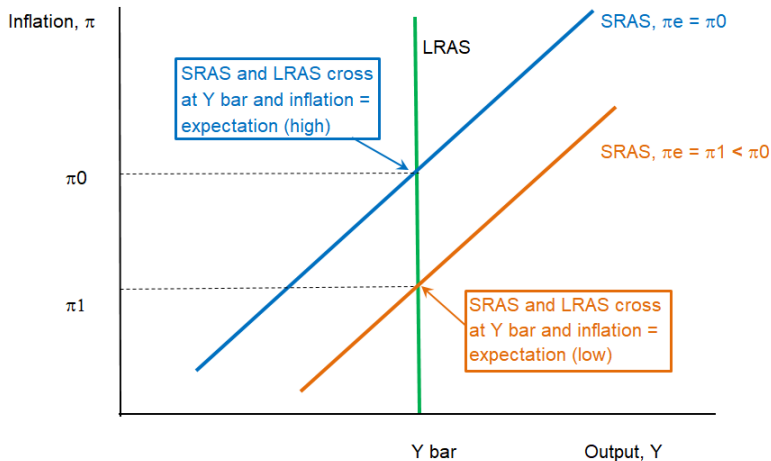
- **Adaptive** expectations: agents look at the past to learn about the future, correcting for mistakes. Ad-hoc rules, for instance:

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

- **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
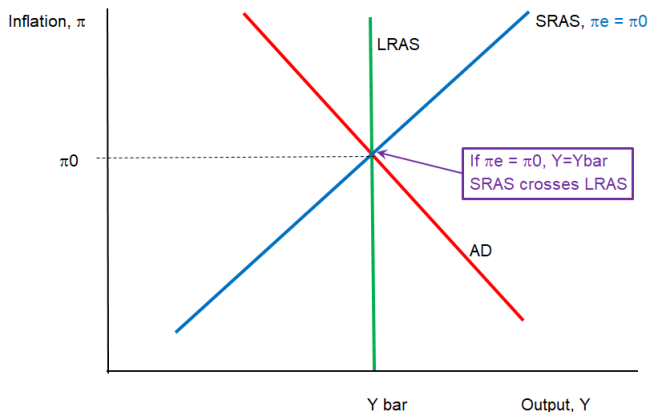
EFFECT OF SUPPLY SHOCK

- 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

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

- 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).
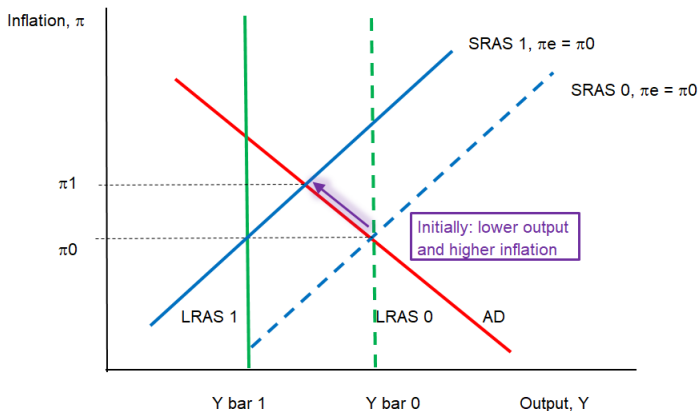
- The shock moves both supply curves.

AS shock
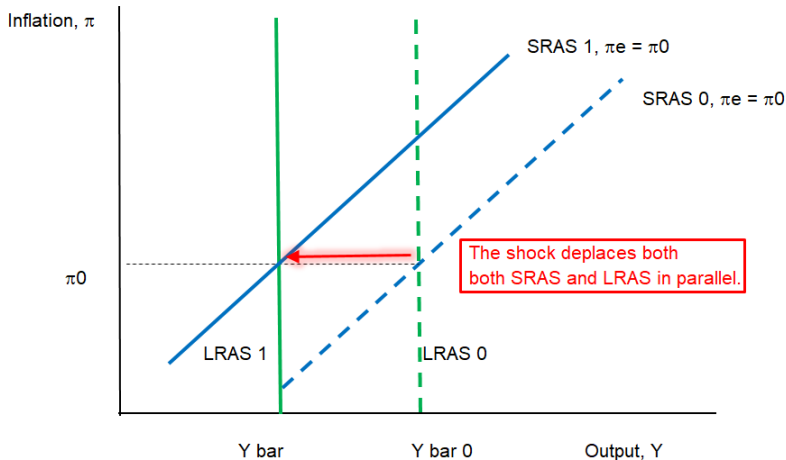
Passive policy: initial adjustment

- Initially output decrease and inflation increase, expectations have not yet moved.
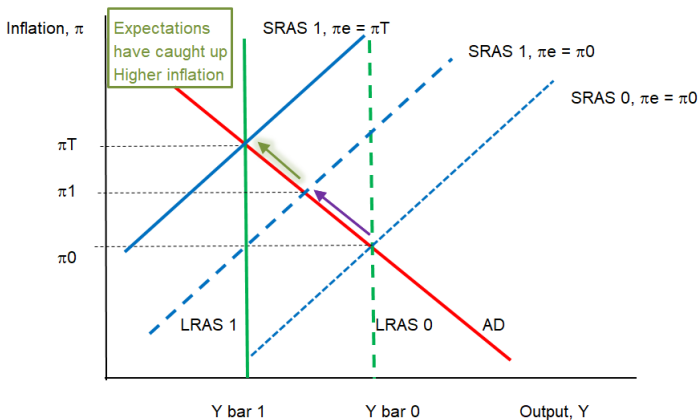
AS shock, no policy reaction

Inflation, π

SRAS 1, $\pi e = \pi 0$

SRAS 0, $\pi e = \pi 0$

$\pi 1$

$\pi 0$

Initially: lower output and higher inflation

LRAS 1

LRAS 0

AD

Y bar 1

Y bar 0

Output, Y

- 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.

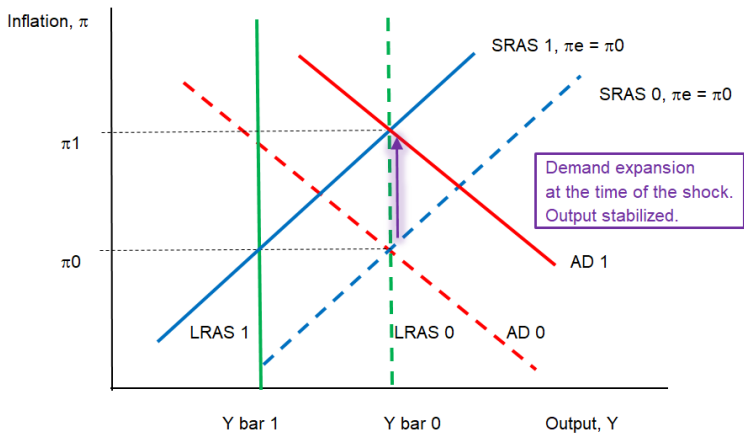- Contractionary policy at the time of the shock, stabilizes inflation.

AS shock, inflation stabilization
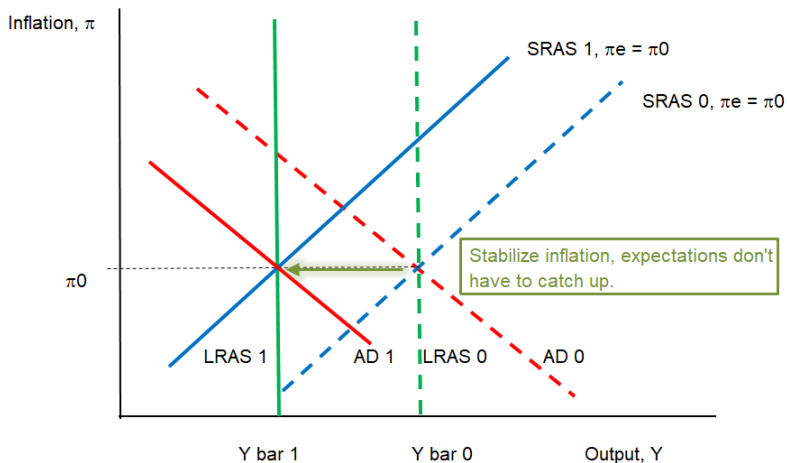
Denial: initial adjustment

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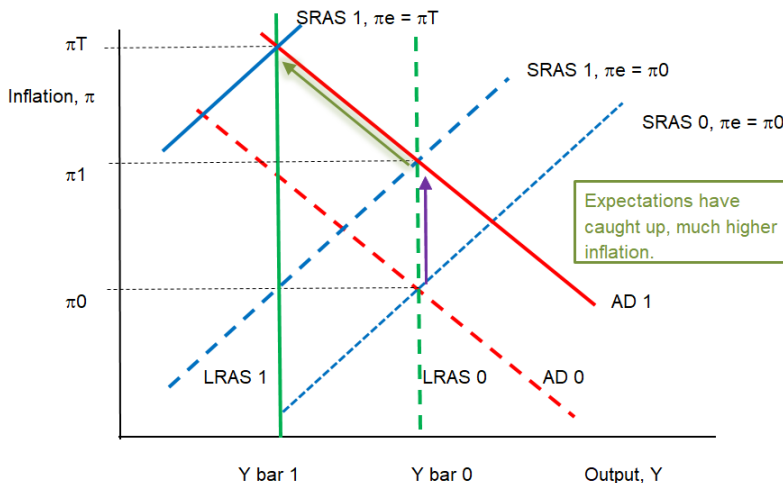

AS shock, temporary output stabilization

Inflation, π

SRAS 1, $\pi e = \pi 0$

SRAS 0, $\pi e = \pi 0$

$\pi 1$

Demand expansion at the time of the shock. Output stabilized.

$\pi 0$

AD 1

LRAS 1

LRAS 0

AD 0

Y bar 1

Y bar 0

Output, Y

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


AS shock, temporary output stabilization

Expectations and surprises

- **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.

- 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.
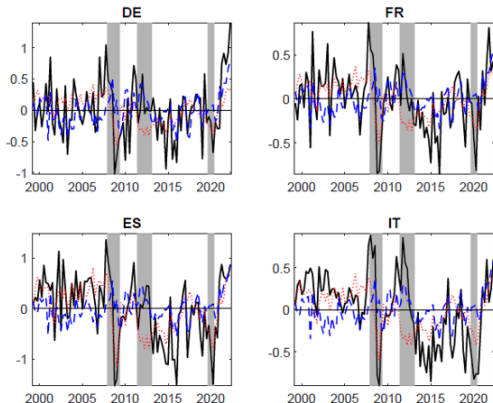
CPI

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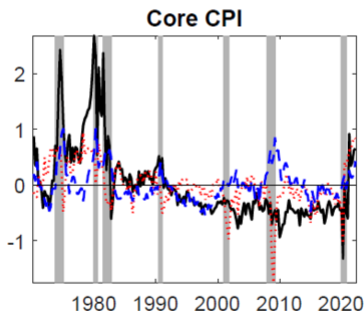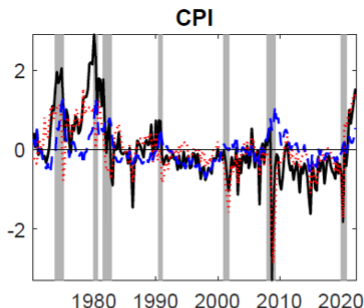
Notes: Quarter-on-quarter, in %. Black: demeaned time series estimates. Red: contributions of the Median Target demand factor. Blue: contributions of the Median Target supply factor. Grey bars: NBER recessions.

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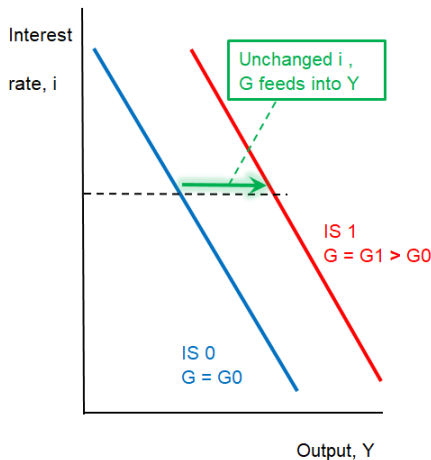
Euro area estimates

- 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.

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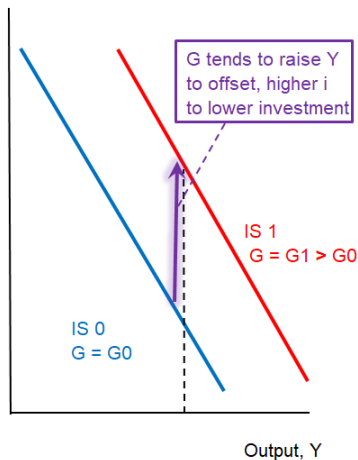
ADDITIONAL SLIDES

Shift of IS

- Effect of higher government spending G. ◂ Return

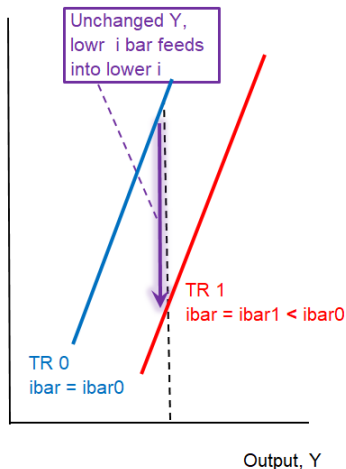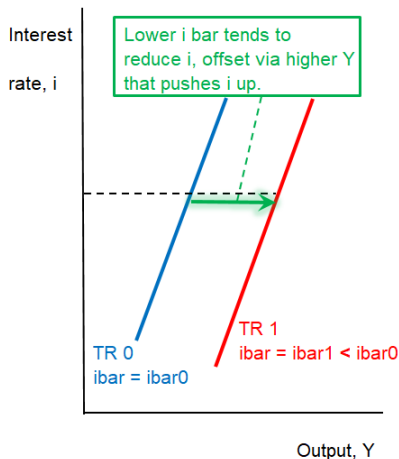**Higher G: thinking horizontal**   **Higher G: thinking vertically**

Shift of TR

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

- 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):
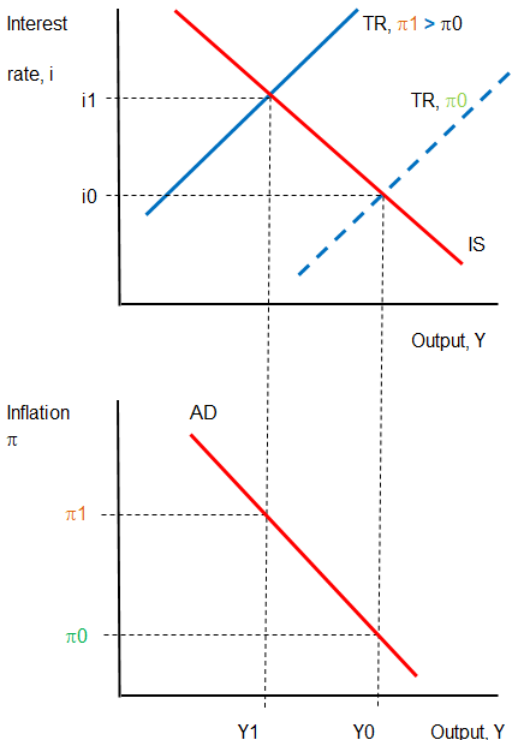
$$M - P = l_1 Y - l_2 i$$

- 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.

IS-TR and AD

- Expansionary fiscal policy. ◄ Return

Fiscal expansion