

MACROECONOMICS 042EC

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# 03 – Analysis in the medium run

## Transitions from short- to medium run (Ch. 9)

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# What to expect from this class

- We'll study how production, interest rates and inflation rates adjust when shifting from the short-run equilibrium to the medium-run equilibrium
- In particular:
  - the IS-LM-PC model
  - the adjustment dynamics
  - the effect of a fiscal consolidation policy
  - the effect of an increase in oil prices

# Heading towards the IS-LM-PC model

- We started (block 2) by studying the short-run dynamics
  - Companies were willing to offer any quantity of product for a given price. Production is determined by demand
  - IS-LM model that jointly analyses the goods market and the financial markets.
- We then have seen (block 3 so far)
  - how wages and prices are determined and how their changes affect output in the medium term
  - how unemployment is related to changes in inflation (Phillips curve PC)
- Now we put it all together
  - We study the behaviour of output, interest rates and inflation as we move from a short-run to a medium-run equilibrium.
  - We use the IS-LM-PC model

- IS: relationship between interest rate and level of output when the goods market is in equilibrium

$$\text{IS relation: } Y = C(Y - T) + I(Y, \overbrace{i - \pi^e}^r) + G$$

(+)
(+)
(-)
(+)

- role the interest rate set by the central bank
- Role of risk premium associated with the soundness of the financial system
- LM: the Central Bank sets the nominal interest rate to influence the real interest rate and ensure equilibrium in financial markets

$$\frac{M}{P} = YL(\underbrace{i - \pi^e}_{-}) \longrightarrow i = \bar{i}$$

- Phillips curve PC: relationship between the change in inflation and the deviation of the unemployment rate from its natural rate

$$\pi_t - \pi_{t-1} = -\alpha(u_t - u_n)$$

- The Phillips curve is represented by the following relationship, if expectations are adaptive:

$$\pi_t - \pi_{t-1} = -\alpha(u_t - u_n)$$

- if  $u_t > u_n \rightarrow$  inflation decreases
- if  $u_t < u_n \rightarrow$  inflation increases

If expectations are anchored:

$$\pi_t = \pi^* + (m + z) - \alpha u_t$$

- In general, the Phillips curve is

$$\pi_t - \pi_t^e = -\alpha(u_t - u_n)$$

- We now rewrite the Phillips curve in terms of the level of output instead of the unemployment rate.

$$\pi_t - \pi^e = -\alpha(u_t - u_n)$$

Recall the definition of unemployment rate

$$u \equiv \frac{U}{L} = \frac{L - N}{L} = 1 - \frac{N}{L}$$

Recalling the production function  $Y = N$

$$u_t = 1 - \frac{Y_t}{L} \quad \longrightarrow \quad Y_t = L(1 - u_t)$$

When  $u = u_n$ , production is equal to the natural level of production  $Y_n$ , referred to as **potential output**

$$u_n = 1 - \frac{Y_n}{L} \quad Y_n = L(1 - u_n)$$

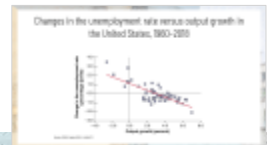
Let's re-write  $u_t - u_n$  in terms of  $Y$   $u_t - u_n = \left(1 - \frac{Y_t}{L}\right) - \left(1 - \frac{Y_n}{L}\right) \longrightarrow$

$$\longrightarrow u_t - u_n = -\frac{Y_t}{L} + \frac{Y_n}{L} \longrightarrow u_t - u_n = -\frac{Y_t - Y_n}{L} \longrightarrow Y_t - Y_n = -L(u_t - u_n)$$

We can now replace in the Phillips curve

$$\pi_t - \pi^e = \frac{\alpha}{L}(Y_t - Y_n)$$

Difference between  $Y_t$  and  $Y_n$  is the **output gap**

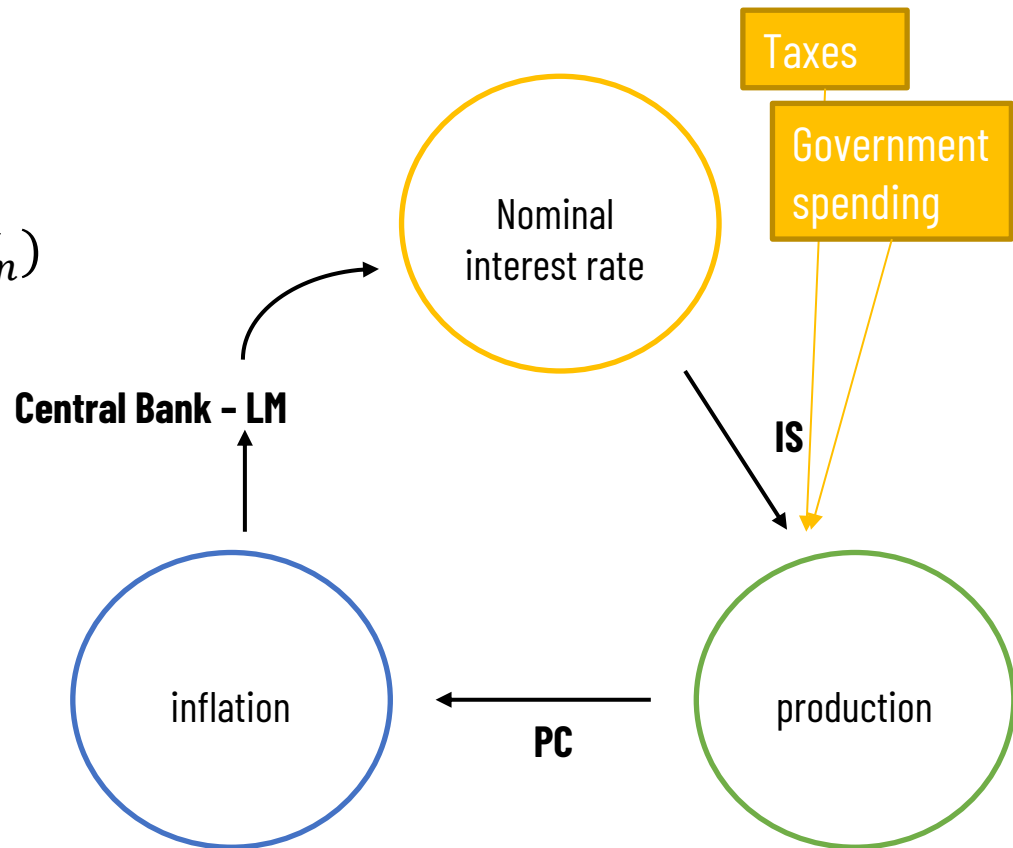


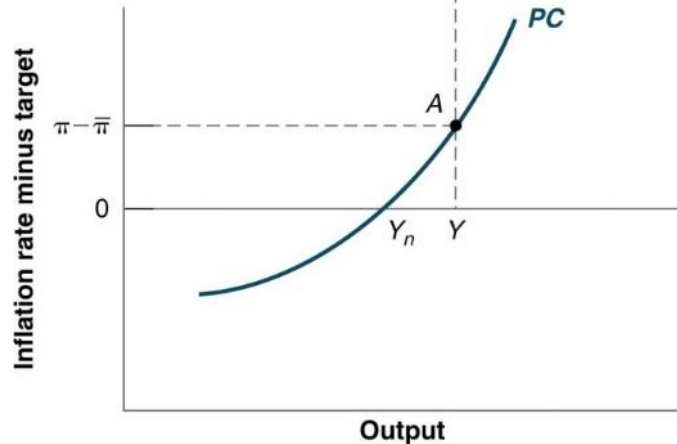
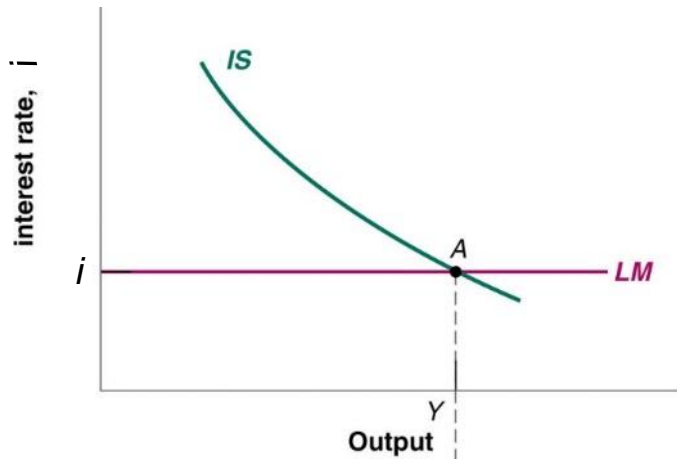
- If **expectations are anchored**,  $\pi^e = \bar{\pi}$  and  $\pi_t - \bar{\pi} = \frac{\alpha}{L}(Y_t - Y_n)$
- when output is higher than its potential level, the output gap is positive and inflation is higher than the fixed expected rate  $\bar{\pi}$ 
  - Remember, unemployment will be lower than the natural level
- when output is lower than its potential level, the output gap is negative and inflation is lower than the fixed expected rate  $\bar{\pi}$ 
  - Remember, unemployment will be higher than the natural level
- If these deviations happen too frequently, people will stop trusting  $\bar{\pi}$  and shift to adaptive inflation expectations ( $\pi_t^e = \pi_{t-1}$ )  $\rightarrow$  PC becomes

$$\pi_t - \pi_{t-1} = \frac{\alpha}{L}(Y_t - Y_n)$$

- when output is higher than its potential level, the output gap is positive and inflation increases
- when output is lower than its potential level, the output gap is negative and inflation decreases
- How do we know what is  $Y_n$ ? We need to estimate it through econometrics.

$$\left\{ \begin{array}{l} IS: Y_t = C(Y_t - T) + I(Y_t, i - \pi^e + x) + G \\ \\ LM: i_t = i^* \\ \\ PC: \pi_t - \bar{\pi} = \frac{\alpha}{L} (Y_t - Y_n) \end{array} \right.$$

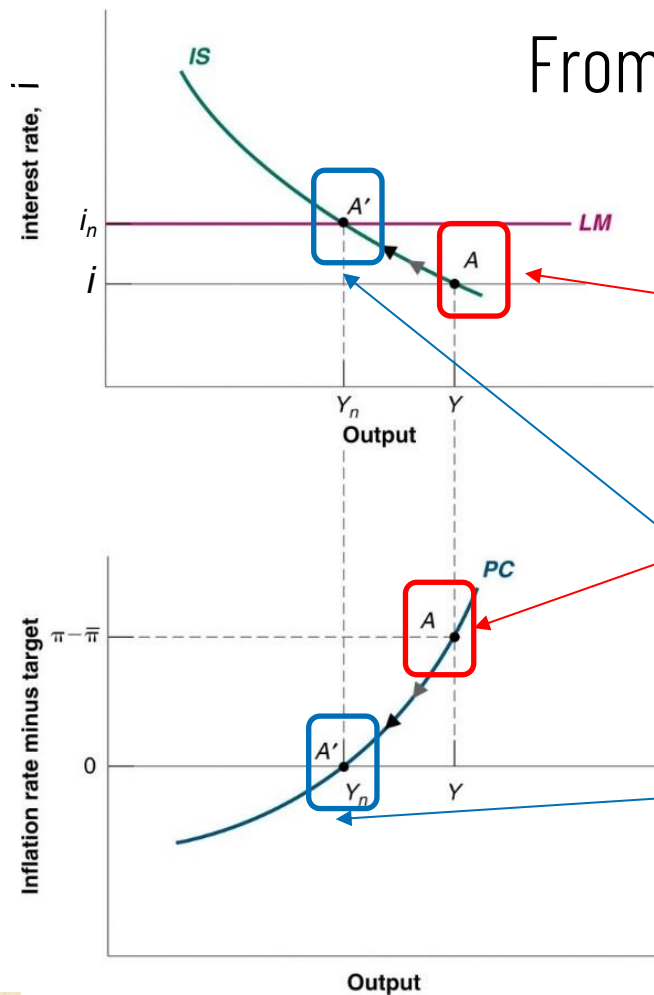




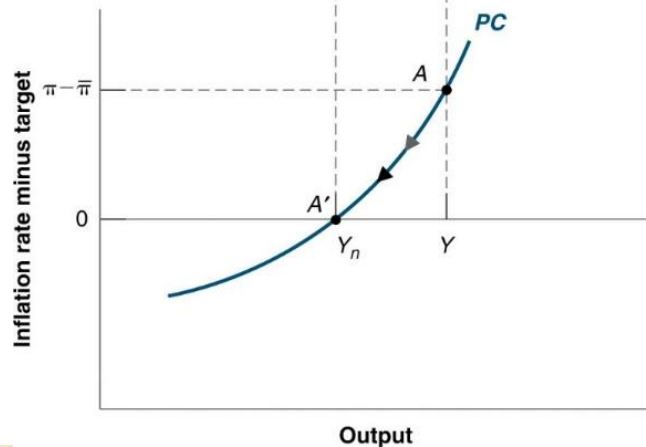
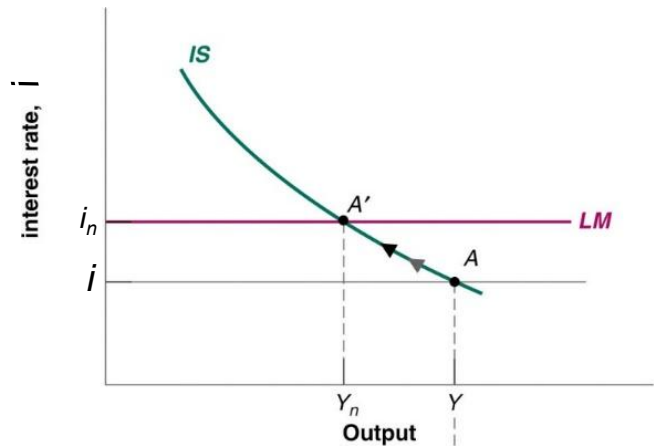
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- From the IS-LM curve we can explain the short-term equilibrium level of output.
- Depending on whether this level is higher or lower than the natural level of production, inflation will be higher/lower than expected
- When actual output corresponds to the potential level  $Y_n$ , actual inflation  $\pi$  corresponds to expected inflation  $\pi^e$ 
  - In the graph,  $Y_t > Y_n$  so inflation in year  $t$  will be higher than expected

# From short- to medium-run

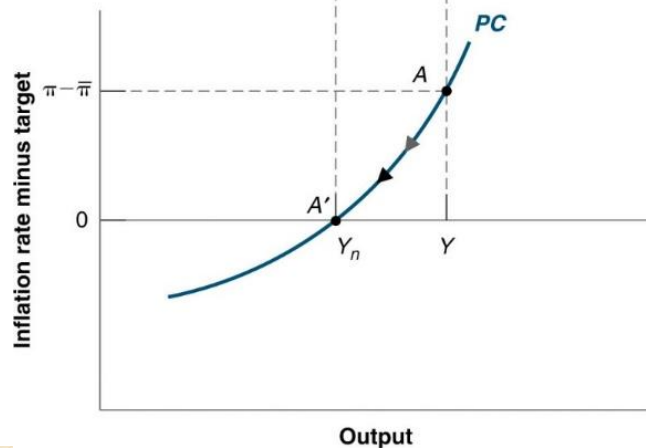
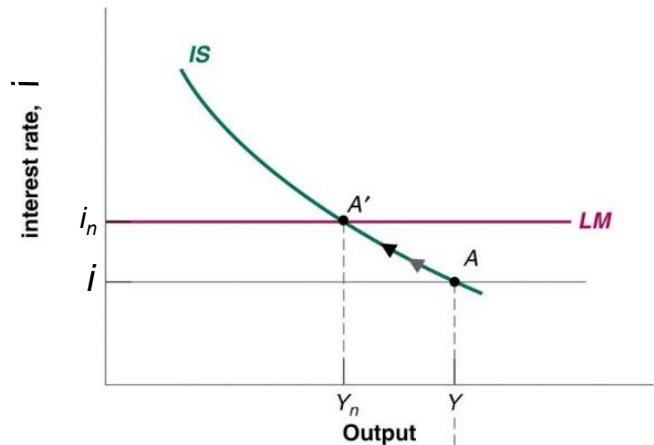


- Assume the central bank sets the policy interest rate  $i$ .
- From the IS, in the short-run this rate corresponds to a level of output  $Y$ : **short-run equilibrium in A**
- From the CP: if this level of output is higher than  $Y_n$ , then inflation is higher than expectations (anchored at  $\bar{\pi}$ )
- Policy will react to stop rising inflation (otherwise people will drop *anchoring* and start having *adaptive* expectations).
  - Central bank will increase the policy rate  $i$  to  $i_n$
  - Higher  $i \rightarrow$  output declines (RECESSION) and returns to its potential level
- **New equilibrium in A'**
  - price pressure is removed: in A' inflation is as expected (prices increase as expected).
  - Constant increase in inflation



$$\left\{ \begin{array}{l} IS: Y_t = C(Y_t - T) + I(Y_t, i - \pi^e + x) + G \\ \\ LM: i_t = i^* \\ \\ PC: \pi_t - \bar{\pi} = \frac{\alpha}{L} (Y_t - Y_n) \end{array} \right.$$

- The real interest rate at which output is at its potential level and inflation constant is the natural (or 'neutral') interest rate  $i_n$  (or **Wicksell interest rate**)
  - $r_n$  is the wicksellian (natural) real interest rate
- Over the medium run, the economy converges to the natural level of output and stable inflation.
- If the central bank wants to achieve a constant level of inflation, then the initial boom must be followed by a recession.
  - Unless the natural rate of output increases: this should be our focus!

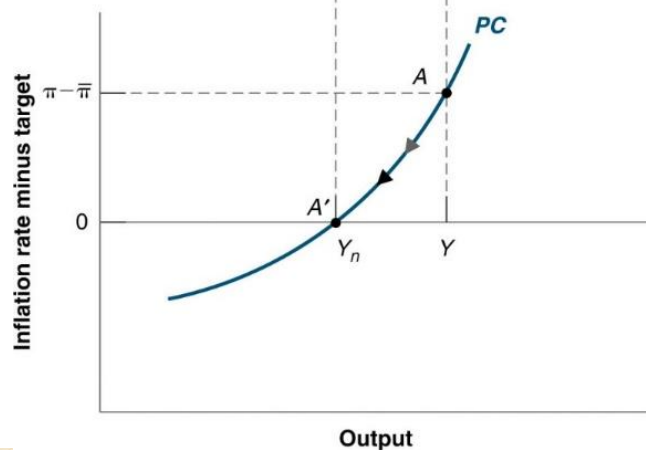
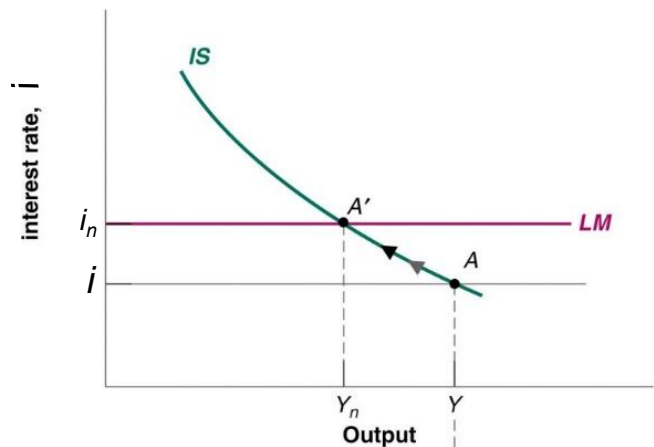


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- If output remains above potential and inflation remains above target, policy is likely to react for two reasons.
- First, the mandate of the central bank is to keep inflation close to the target.
- Second, if it does not react, what we saw happen in the 1970s and 1980s will happen again: inflation expectations will de-anchor.
  - Seeing that inflation continues to exceed the target, wage setters will change the way they form expectations, and likely expect inflation to equal past inflation. The Phillips curve relation will become a relation between the change in inflation and the output gap.

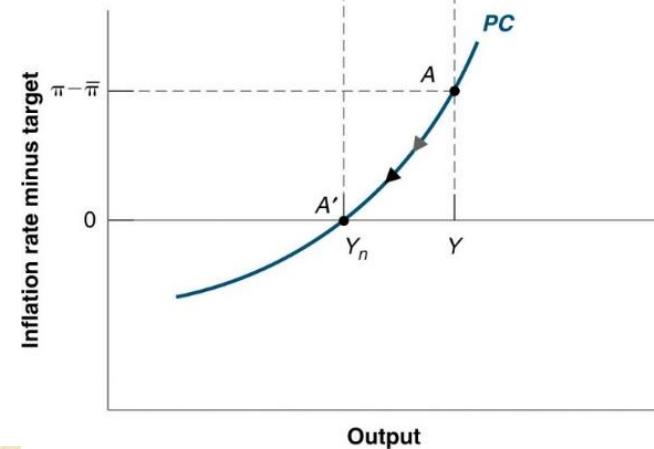
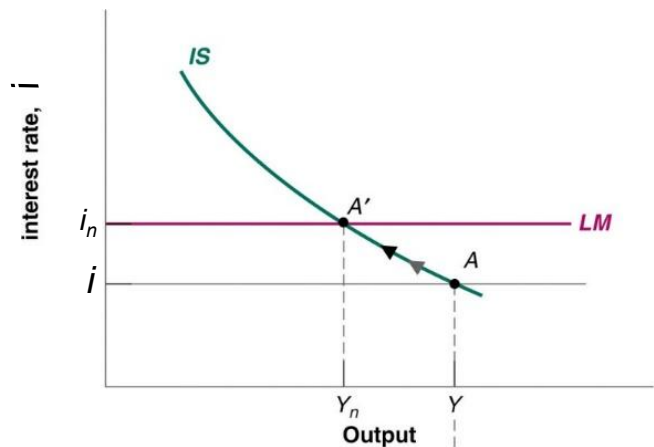
$$\pi_t - \pi_{t-1} = -\alpha(u_t - u_n)$$

- If the output gap remains positive, inflation not only will be higher than the target but will start increasing.
- The central bank will have to act to stop it from increasing, and eventually return it to target. Better to react early before expectations de-anchor.



$$\left\{ \begin{array}{l} IS: Y_t = C(Y_t - T) + I(Y_t, i - \pi^e + x) + G \\ LM: i_t = i^* \\ PC: \pi_t - \bar{\pi} = \frac{\alpha}{L}(Y_t - Y_n) \end{array} \right.$$

- The central bank acts when the economy is in A. During the transition from A to A', prices keep increasing more than expected, but the gap gets smaller and smaller
- Make sure to be confident in explaining that prices in A' are higher than in A.



$$\left\{ \begin{array}{l} IS: Y_t = C(Y_t - T) + I(Y_t, i - \pi^e + x) + G \\ \\ LM: i_t = i^* \\ \\ PC: \pi_t - \bar{\pi} = \frac{\alpha}{L} (Y_t - Y_n) \end{array} \right.$$

- In the medium run (A'), output returns to its natural level:  $Y = Y_n$ .
- In parallel, unemployment returns to the natural unemployment rate:  $u = u_n$ .
- With unemployment and output at the natural rate, the inflation rate returns to the target rate  $\pi_t = \bar{\pi}$ .
- Natural nominal interest in A' is  $i_n$ , the real will be  $r_n$ 
  - real borrowing rate is given in turn by  $r_n + x$ , where  $x$  is the risk premium
- Nominal interest rate is  $i = r + \pi^e$ , so in the medium run it will be  $i_n = r_n + \bar{\pi}$

# Medium run equilibrium and the neutrality of money

In the medium-run equilibrium, with  $r = r_n$  (Wicksellian real interest rate),

- $Y = Y_n$
  - $u = u_n$
  - $\pi = \bar{\pi}$
  - $i_n = r_n + \bar{\pi}$
- We will also have equilibrium between real-money supply and demand :  $\frac{M}{P} = Y_n L(i_n + \bar{\pi})$ 
    - All variables on the right (real-money demand) are constant in equilibrium (called 'stationary state').
    - Hence the left handside (real-money supply) must be constant as well
    - This means that in the medium run, the ratio between money and prices will not change. This implies that the prices P must grow at the same rate as the nominal money stock M

$$\pi = g_m$$

Which in turns imply that, if  $\pi = \bar{\pi}$ , then  $i_n = r_n + g_m$

- A crucial bottom line is that, in the medium run, the real economic variables (output, unemployment, real rate of interest) are independent of monetary policy

- What monetary policy can determine is the rate of inflation and the nominal interest rate.
- In the medium run, a higher rate of money growth leads only to higher inflation and higher nominal interest rates. The other real economic variables do not depend on the money growth in the medium run.
- The fact that monetary policy does not affect real variables in the medium run is referred to as **the neutrality of money**.

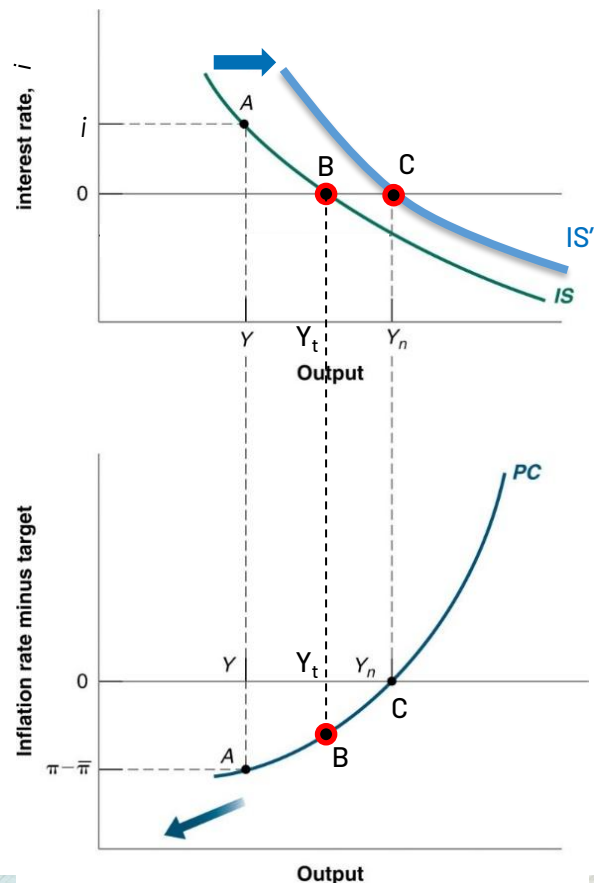
# Adjustment timing and complications

- The adjustment to the medium-run equilibrium seemed smooth and easy.
- Reality is more complex, for two reasons;
  - It is difficult for the central bank to precisely estimate potential output  $Y_n$ , and thus how far output is from potential.
  - It takes time for the economy to respond.
- When the government observes that actual inflation is different than expected, it is a signal that actual output is different than potential. But it is hard to compute how much should interest rate  $r$  be changed
  - What are  $i_n$  and  $r_n$ ? Quite difficult to estimate
- The economy adjusts slowly to changes in  $i$  or  $r$ : investment spending reacts but it takes time until the whole process is over (multiplier, consumption and investment decisions)
- Meanwhile, as long as output remains above potential, inflation being higher than expected (prices increase more than expected).
  - A recession could be needed to bring back inflation to the desired target

# Zero lower bound and deflation spirals

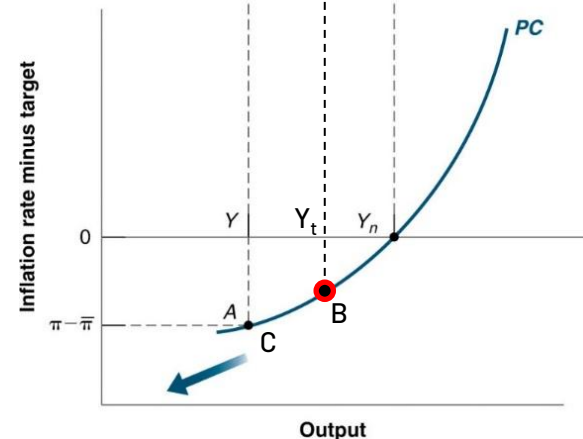
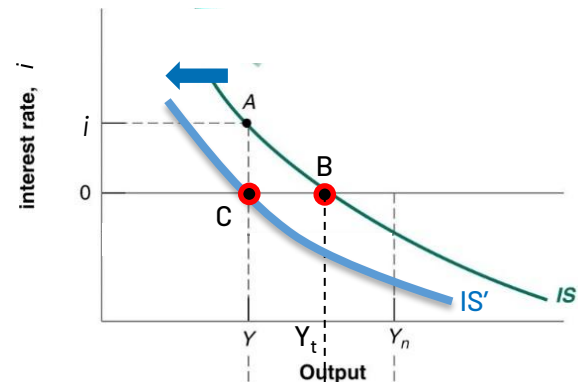
- Assume  $\pi^e$  is anchored to  $\bar{\pi}$
- Suppose the economy is in a recession
  - $Y_t < Y_n$ , we are in A
- Hence inflation is lower than expected (see PC curve)
- Central bank should reduce the real interest rate ( $r = i - \pi^e$ ) by reducing  $i$  (lowering the LM curve)
  - Depending on how bad the economy is doing,  $r_n$  could be negative. Can you see that the economy in the picture has a negative  $r_n$ ?
  - If  $i$  is already low, there is small room to act
  - $i$  must stop at zero, we cannot reach  $Y_n$ , we stop at B ( $Y_t$ )
- If  $\pi^e$  is positive,  $r$  could be brought to negative values
- Assume that  $\pi^e$  increases a bit  $\rightarrow$  IS would shift to the right (to C)

$$IS: Y_t = C(Y_t - T) + I(Y_t, i - \pi^e + x) + G$$



- If  $Y_t$  is much lower than  $Y_n$ , the economy might be experiencing deflation ( $\pi < 0$ )
- However, if we have deflation, it's very difficult that  $\pi^e$  remains positive. It's likely that  $\pi^e$  will go down and become negative (adaptive)
- If that happens, even with  $i$  stuck at 0,  $r$  will increase
  - Graphically the IS curve would move to the left
  - $r = i - \pi^e$
- IS moves to the left: larger negative output gap, and even worse deflation
  - If inflation expectations de-anchor and keep going down, that's a terrible spiral (IS keeps shifting left)

$$IS: Y_t = C(Y_t - T) + I(Y_t, i - \pi^e + x) + G$$



- What's the deflation spiral?
- In presence of continuous deflation. People will start de-anchor expectations: in the PC,  $\bar{\pi}$  will be replaced with  $\pi_{t-1}$ 
  - $\pi^e$ , which is in the IS curve, becomes equal to  $\pi_{t-1}$  and, in this context, keeps going down
- With expectations of further deflation (negative inflation), prices will decline even further next year
- Higher expected deflation (lower  $\pi^e$ ) means higher  $r$ , which means lower output in the IS (IS shifts to the left), which means worse output gap, which means even more negative inflation...
- The IS risks shifting further left, with the equilibrium moving towards bottom left of the PC curve

$$IS: Y_t = C(Y_t - T) + I(Y_t, i - \pi^e + x) + G$$

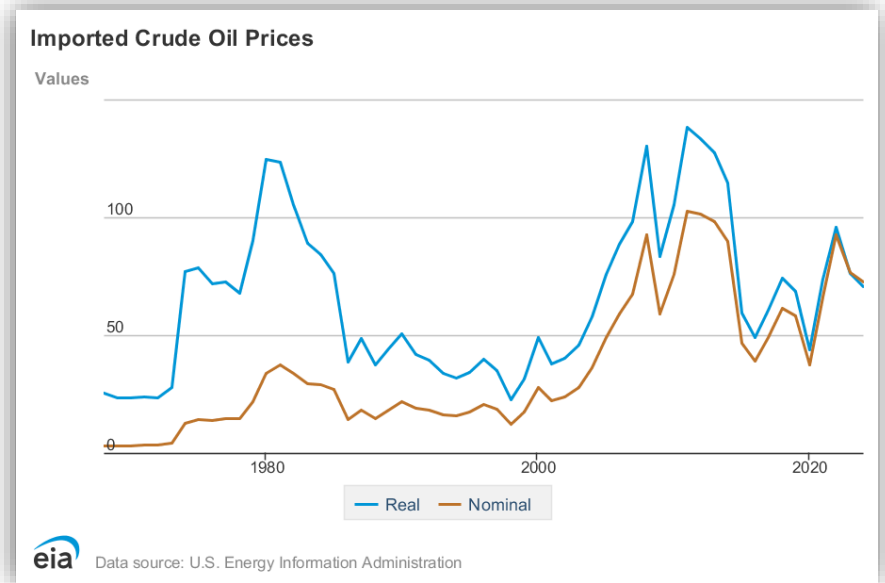
$$IS: Y_t = C(Y_t - T) + I(Y_t, i - \pi^e + x) + G$$

- This scenario played out during the Great Depression from 1929 to 1933, until other policy measures were taken and the economy started turning around.
- During the recent Great Recession (2008 onward) there were similar worries: negative output gap and a nominal rate down to zero in the major advanced countries,
  - Inflation decreased and, in some countries, – Greece, Spain, and Portugal – turned to deflation.
  - This limited the ability of the central bank to decrease the real rate and increase output.
- The spiral did not happen: deflation remained limited.
- One reason for this is that inflation expectations remained largely anchored. People continued to trust  $\pi^e = \bar{\pi}$

# Exercise: effects of an increase in oil prices

- So far we have looked at shocks to demand: shocks that shifted the IS curve but left potential output unaffected (→ PC curve did not move).
- There are other shocks, however, that affect both demand and potential output and play an important role in fluctuations
- We take the price of oil as an example

- Look at the Nominal and the Real Price of Oil, 1970–2018
- Over the last 40 years, there have been two sharp increases in the real price of oil, the first in the 1970s and the second in the 2000s.
- 1970s: O P E C (the Organization of Petroleum Exporting Countries) act as a monopoly and increased oil prices.
- 2000s: The fast growth of emerging economies led a rapid increase in world oil demand, and thus a steady increase in real oil prices.
- 2008: A large recession led to a sudden decrease in the demand for oil, and thus falling oil prices.
- 2014+: A combination of increased supply due to the increase in U.S. shale oil production and the partial breakdown of O P E C led to sudden drop in oil prices.
- 2020: COVID crisis (recession)



$$\frac{W}{P} = F(u, z)$$

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REAL-WAGE SETTING RELATION

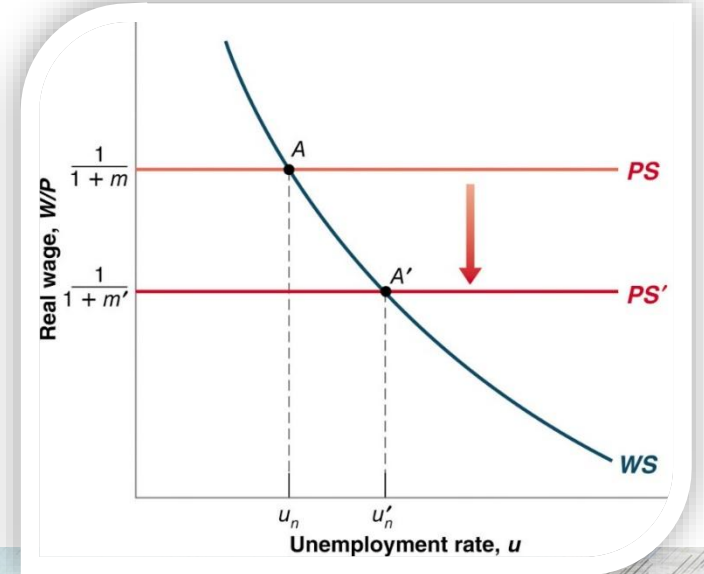
$$\frac{W}{P} = \frac{1}{(1 + m)}$$

REAL-PRICE SETTING RELATION

- Intuitively higher oil prices should mean higher costs for consumers.
- Also for firms? Intuitively yes: a factor of production is more expensive
- But: remember our simplifying assumption that firms use only labour? Firms don't have other production factors!
- Not a problem, we can assume that firms increase their mark-up to cover for their higher costs
  - Firms have to pay more for the oil, the real wage they can pay is lower.
- Getting workers to accept the lower real wage requires an increase in unemployment.
- The natural rate of unemployment increases

$$\left\{ \begin{array}{l} IS: Y_t = C(Y_t - T) + I(Y_t, i - \pi^e + x) + G \\ \quad \quad \quad \underbrace{\hspace{2cm}}_{(+)} \quad \quad \quad \underbrace{\hspace{2cm}}_{(+)} \quad \quad \quad \underbrace{\hspace{2cm}}_{(-)} \\ LM: i_t = i^* \\ PC: \pi_t - \pi^e = \frac{\alpha}{L}(Y_t - Y_n) \end{array} \right.$$

$$u_n = \frac{m + z}{\alpha}$$



$$IS: Y_t = \underbrace{C(Y_t - T)}_{(+)} + \underbrace{I(Y_t, i - \pi^e + x)}_{(+)} + G \quad (-)$$

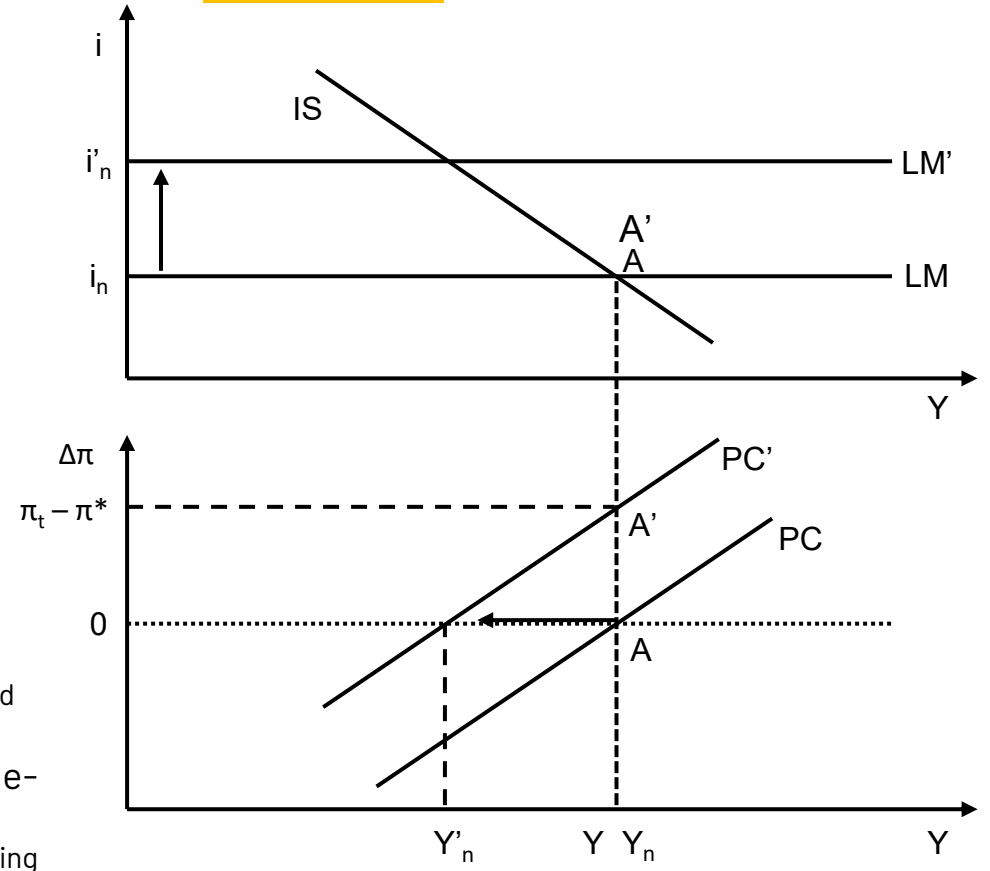
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$$PC: \pi_t - \pi^e = \frac{\alpha}{L}(Y_t - Y_n)$$

$$u_n = \frac{m + z}{\alpha}$$

$$Y_n = L(1 - u_n)$$

- Initial equilibrium in A:  $i = i_n$  and  $Y = Y_n$ 
  - Assume inflation expectations are anchored to  $\pi^*$
- Oil price up  $\rightarrow$   $m$  up  $\rightarrow$  higher  $u_n$
- Higher  $u_n \rightarrow Y_n$  goes down to  $Y'_n$ 
  - PC curve moves left
  - New equilibrium on PC is A'
  - Nothing changes in the IS LM
- Our "potential" just reduced, meaning we are producing too much now. Positive output gap because  $Y > Y'_n$ 
  - We are in A', Inflation is suddenly higher than expected
- Inflation increasing  $\rightarrow$  Central bank tightens monetary policy to make sure individuals don't de-anchor their inflation expectations
  - increase the interest rate until inflation stops exceeding expectations



$$IS: Y_t = C(Y_t - T) + I(Y_t, i - \pi^e + x) + G$$

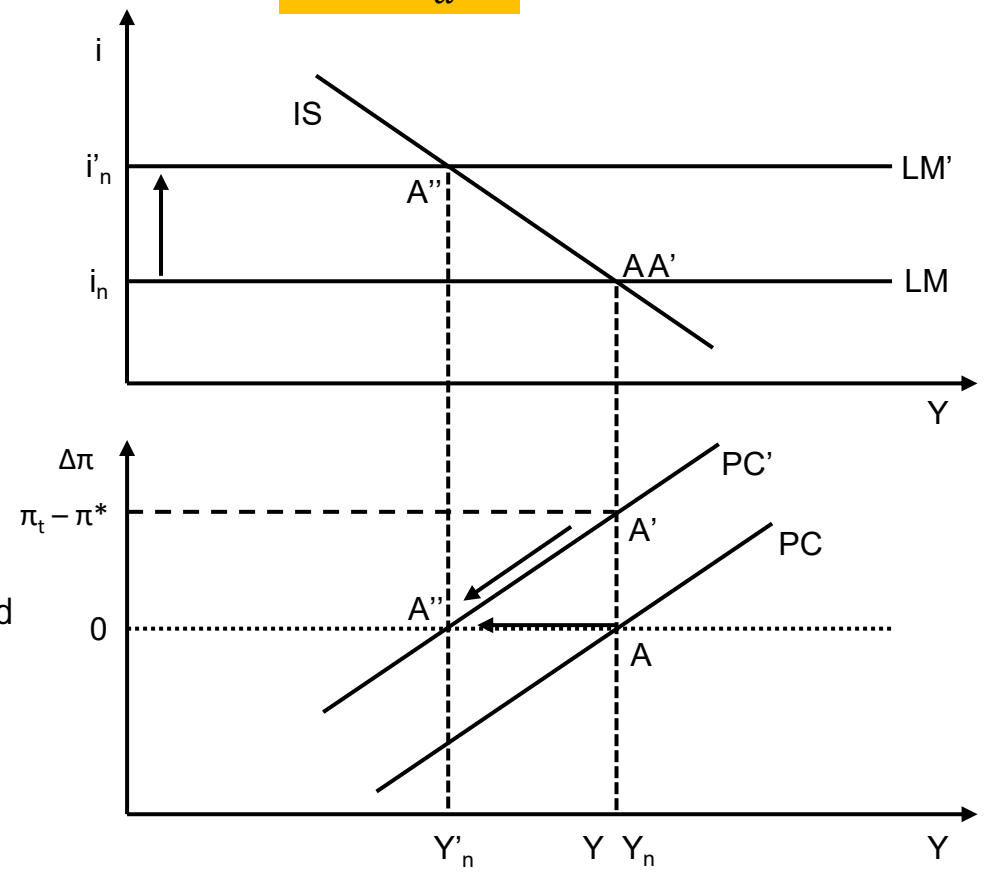
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$$Y_n = L(1 - u_n)$$

- Initial equilibrium in A:  $Y = Y_n$
- Oil price up  $\rightarrow$  higher  $m \rightarrow$  higher  $u_n$
- Higher  $u_n \rightarrow$  lower  $Y_n$ , PC curve moves left
- Positive output gap because  $Y > Y'_n$
- Inflation increasing  $\rightarrow$  Central bank increases the interest rate
- Higher interest rates induces a recession
- While output reduces towards  $Y'_n$  (recession), prices are still increasing more than expected
- This period is called STAGFLATION: STAGnation + INFLATION
- Once inflation stops being «higher» than expected,
  - central bank will stop increasing interest rate
  - Recession and inflation end, stagflation ends



# Take-home points

- Shocks or policy-changes have different effects in the short vs mid run
  - Depending on the focus of policymakers, you might prefer a policy over another
  - Fiscal consolidation might be detrimental in short run, but virtuous in mid-run
  - If policymakers expect the transition from short to mid run to be long, they might be tempted to focus on the short run (political economy)
- Typically, the economy returns over time to its medium-run equilibrium
  - It often does not self-stabilise, and it requires an active policy (fiscal or monetary) response



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