Monetary Policy

Part 1: Basic Macroeconomic Concepts

Lecture 4: The Short Run: The IS-MP-PC Model

Prof. Dr. Maik Wolters
University of Würzburg

Outline

Part 1: Basic Macroeconomic Concepts

- Lecture 1: GDP Measurement, Growth and Business Cycles
- Lecture 2: The Long Run: Solow Model and Equilibrium Unemployment
- Lecture 3: The Long Run: Natural Interest Rate and Quantity Theory
- Lecture 4: The Short Run: The IS-MP-PC Model

Part 2: Conventional Monetary Policy

Part 3: Monetary Policy at the Zero Lower Bound on Nominal Interest Rate

Part 4: Monetary and Fiscal Interactions

Part 5: Financial Stability (if time permits)

Mock Exam

Learning Objective of Todays Lecture

Background

- You should be familiar with a version of the IS-LM or AS-AD model.
- Here we will use a different representation, the IS-MP-PC model.
- It replaces the LM curve (that shows the equilibrium from money demand and supply) with an interest rate rule (MP curve: monetary policy curve). It is more consistent with the implementation of (conventional) monetary policy via setting a policy rate directly.
- The IS-MP-PC model is a slightly simplified version of the workhorse New Keynesian model. The intuition is the same, but it is much easier to work with.
- While we have analyzed long-run developments during the last two lectures, from now on the representation changes to deviations from such long-run movements, i.e. the focus will be on business cycles.

Learning Objectives

1. Understanding the Phillips Curve (PC)
2. Understanding the most important demand components
3. Understanding the IS-curve
4. Understand why the adjustment of inflation expectations is key for the effects of shocks in this framework

Literature

Required reading

- Karl Whelan (2020). Lecture Notes on Macroeocnomics, Chapter 1 “Introducing the IS-MP-PC model“, pp. 7-24. https://www.karlwhelan.com/Macro2/Whelan-Lecture-Notes.pdf

Optional reading

- John R. Hicks (1937). “Mr. Keynes and the "Classics"; A Suggested Interpretation”, *Econometrica* 5(2): 147-159. http://public.econ.duke.edu/~kdh9/Courses/Graduate%20Macro%20History/Readings-1/Hicks_Mr.%20Keynes%20and%20the%20Classics.pdf
- Robert Lucas (1976). “Econometric policy evaluation: A critique”, Carnegie-Rochester Conference Series on Public Policy, vol. 1(1), pages 19-46, January. http://www.macroeconomics.tu-berlin.de/fileadmin/fg124/bindseil/lucas1976.pdf

4.1 The Phillips Curve

Aggregate Supply in the Short to Medium Run

The WS-PS-model from last week's lecture nicely illustrates how imperfections in the labor and product market prevent full wage adjustment and lead to equilibrium unemployment.

- It is, however, (in my view) not very intuitive for studying inflation dynamics over the business cycle.
- Therefore, we will focus on the Phillips curve instead and only refer to the WS-PS-model for discussing the NAIRU and changes in the NAIRU. Note, however, that the Phillips curve can be directly derived from the WS-PS-model so that this is only a different way to illustrate things.

The Phillips curve was discovered in 1958 by A. W. Phillips as an empirical negative relation between wage inflation and the unemployment rate based on data for the UK:

Fig.1. 1861 – 1913

In 1960 Solow and Samuelson confirmed the finding based on US data using price instead of wage inflation.

The Expectation Augmented Phillips Curve

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

Short run

- Holding π_t^e fixed, an unemployment below the natural unemployment rate (implies a positive output gap) leads to inflationary pressure.
- The Phillips Curve has a negative slope, monetary policy can exploit this trade-off in the short-run.

Long run

- Inflation expectations adjust and equal actual inflation.
- Unemployment equals its natural rate which is determined by real rather than monetary factors.
- If monetary policy tries to target an unemployment rate below the NAIRU, this will lead to higher inflation rather than lower unemployment in the long run.

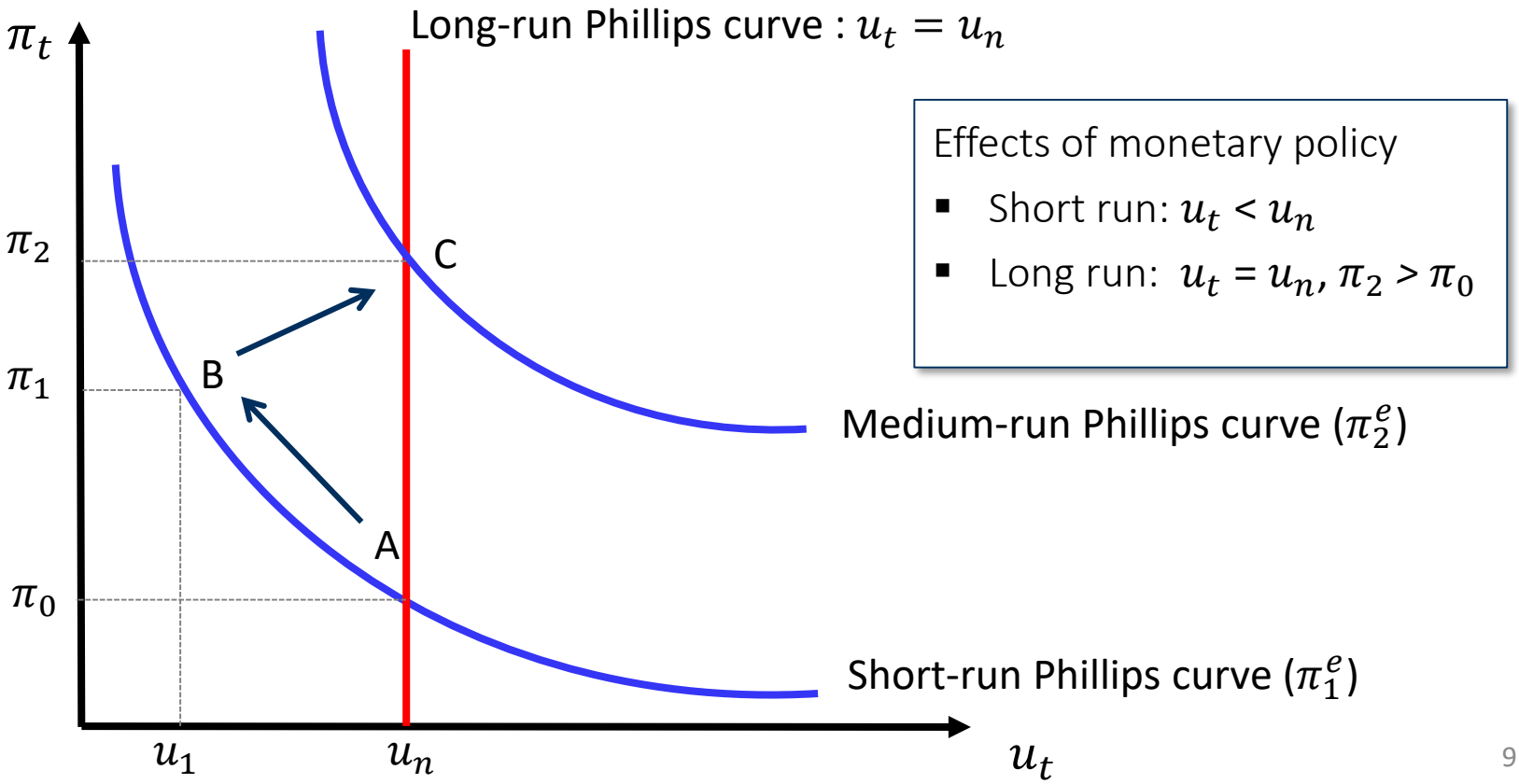
Transition from Short to Long Run

- Expansionary monetary and/or fiscal policy leads to higher demand. Firms hire more workers, employment increases.
- After a while prices start increasing, decreasing the real wage, so that firms make more profits and increase labor demand further.
- Higher level of employment increases the bargaining power of workers (recall the WS-curve) and they demand higher nominal wages.
  - Case 1 (short run): Inflation expectations have not been updated ($\pi_t^e < \pi_t$), so that nominal wage claims are moderate → real wages remain low → unemployment rate stays below natural rate and inflation continues to increase.
  - Case 2 (long run): If inflation is higher for some time, workers will update inflation expectations to $\pi_t^e = \pi_t$. Real wage returns to its long-run average, labor demand decreases, and the unemployment rate returns to its natural level. Only inflation has increased in the long run.

The Phillips Curve (Short and Long Run)

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

- Expansionary monetary policy leads to a reduction in u_t
- Short run: $\pi_t^e = \bar{\pi}_t^e,\ u_1 < u_n \ \rightarrow\ \pi_t \uparrow$
- Medium run: π_t^e adjusts → Phillips curve shifts upwards
- Long run: $\pi_2^e = \pi_2 \ \rightarrow\ u_2 = u_n \ \rightarrow$ long-run vertical Phillips curve



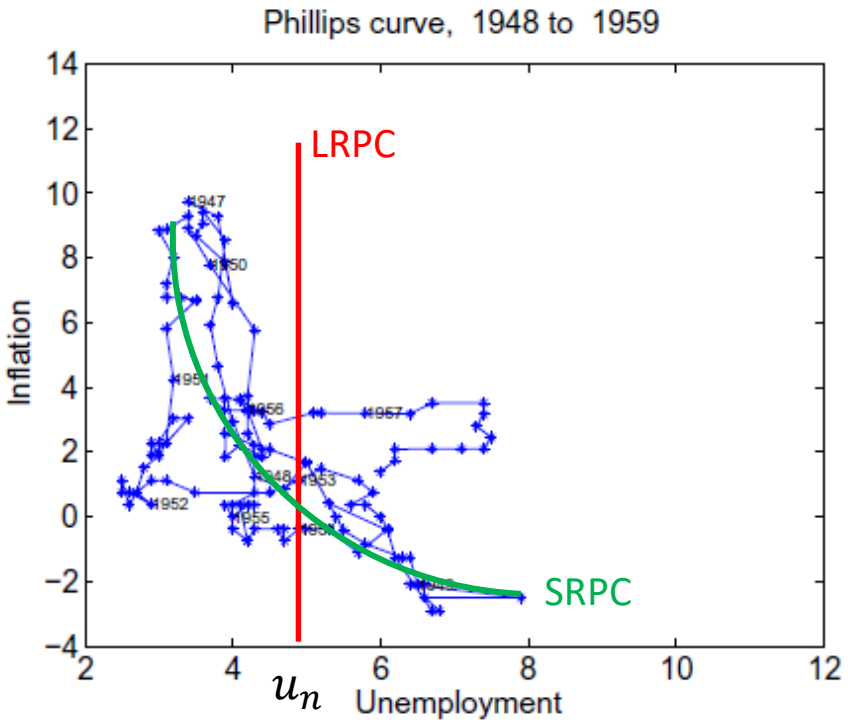
Effects of monetary policy

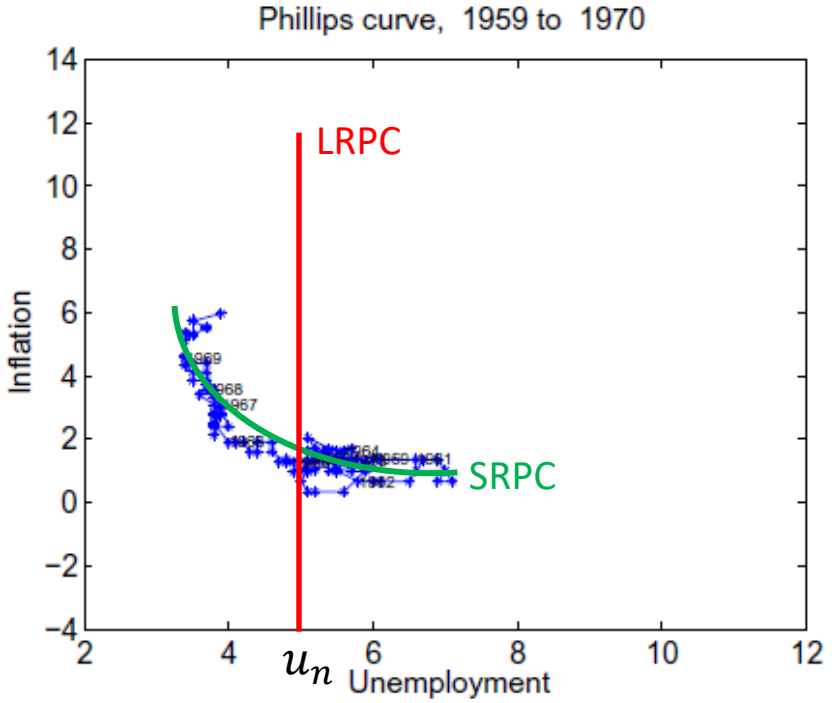
- Short run: $u_t < u_n$
- Long run: $u_t = u_n, \pi_2 > \pi_0$

The Phillips Curve in the 1950s and 1960s

- The Phillips curve was interpreted as choice menu for policy makers highlighting a trade-off between inflation and unemployment. Policy makers aimed at achieving low unemployment at the cost of higher inflation.
- Expansionary monetary and fiscal policy let to a decline in the unemployment rate and an increase in U.S. inflation during the 1960s. We focus on the U.S. here, but developments were similar in most OECD countries.

$$\pi_t = \pi_t^e - \alpha(u_t - u_n) \overset{\pi_t^e = 0}{\cong} -\alpha(u_t - u_n)$$



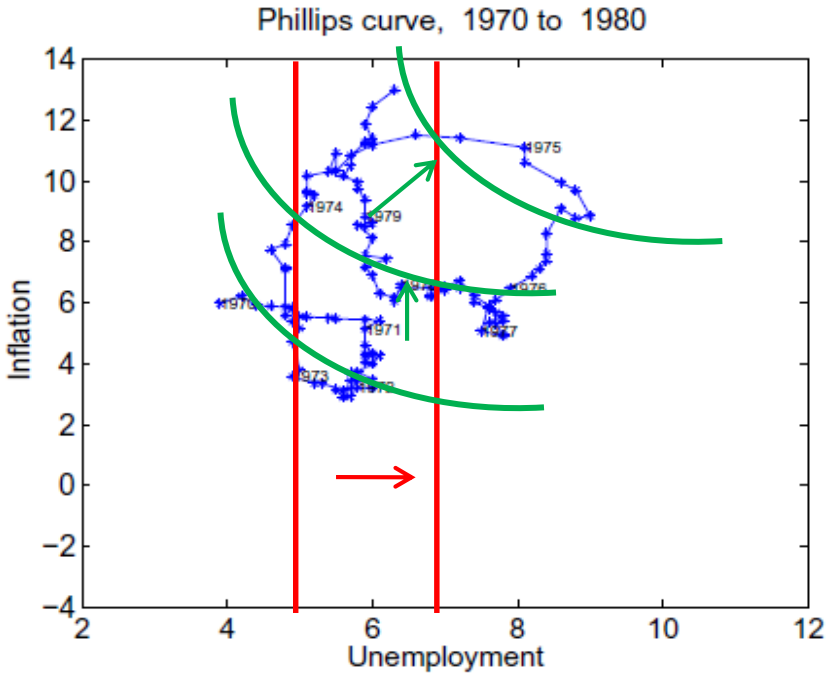


Source: Uhlig (2012), data from 1948-2008, Civilian Unemployment Rate, BLS, monthly, seasonally adjusted, 12 months log-change in the Consumer Price Index for all urban consumers, BLS, monthly data.

The Breakdown of the PC in the 1970s

- Milton Friedman predicted in 1967 that the exploitation of the short-run inflation-unemployment trade-off would lead to an adjustment of inflation expectations (ex. $\pi_t^e = \pi_{t-1}$), so that there is no reduction in the unemployment rate in the medium to long run but only an increase in inflation.
- This prediction was remarkable as empirical data clearly showed a negative relation between u_t and π_t. Usually, there is first an empirical observation and then a theory is developed (ex. Great Depression → Keynesian demand theory), rarely theory predicts a substantial empirical change.
- During the early 1970s inflation moved up as inflation expectations adjusted upwards. The unemployment rate returned to u_n. Afterwards, oil crises increased u_n, so that π_t and u_t moved up in parallel: the traditional Phillips curve broke down. Friedman was correct, that inflation expectations (and a time varying natural unemployment rate) are crucial for a consistent theory.

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



The Lucas Critique

Friedman's presidential address together with the work of Phelps (1967) drew attention to modeling expectation formation that finally resulted in the famous Lucas critique:

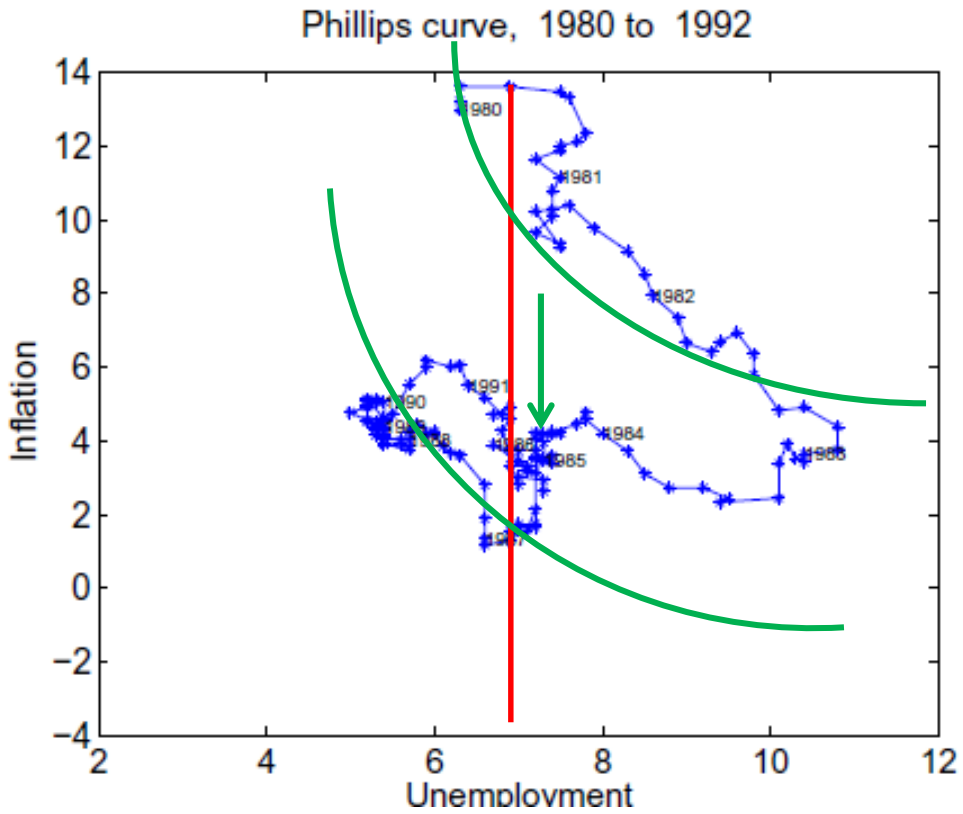
> "The 'Lucas critique' is a criticism of econometric policy evaluation procedures that fail to recognize that optimal decision rules of economic agents vary systematically with changes in policy. In particular, it criticizes using estimated statistical relationships from past data to forecast the effects of adopting a new policy, because the estimated regression coefficients are not invariant but will change along with agents' decision rules in response to a new policy. A classic example of this fallacy was the erroneous inference that a regression of inflation on unemployment (the Phillips curve) represented a structural trade-off for policy to exploit."
>
> The New Palgrave Dictionary of Economics, 2008.

- Lucas, Robert E., Jr. (1976), "Econometric Policy Evaluation: A Critique," in Karl Brunner und Alan Meltzer (eds.), The Phillips Curve and Labor Markets. Carnegie-Rochester Conference Series on Public Policy, Vol. 1, pp. 19-46.
- Nobel price in economics 1995.

Disinflation in the Early 1980s

- At the beginning of the 1980s Paul Volcker became Fed Chairmen. He was committed to reducing inflation. Via increasing the interest rate, he created a recession that brought down inflation.
- Inflation expectations adjusted downwards and finally the unemployment rate returned to its natural rate
- The downward adjust occurred much faster than expected as the clear communication and commitment to disinflation reduced inflation expectation fast.

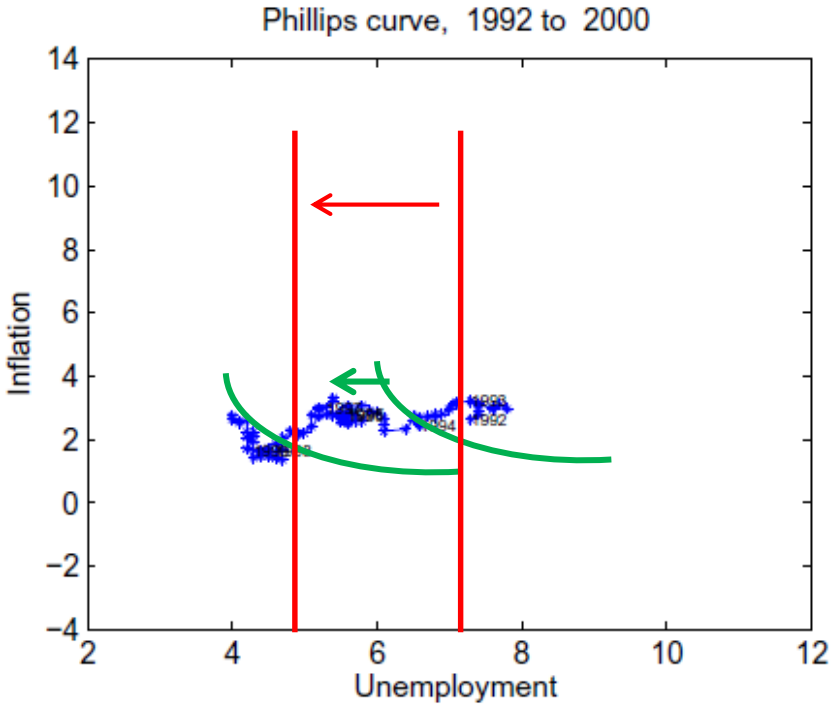
$$\pi_t = \pi_t^e - \alpha(u_t - u_n)$$

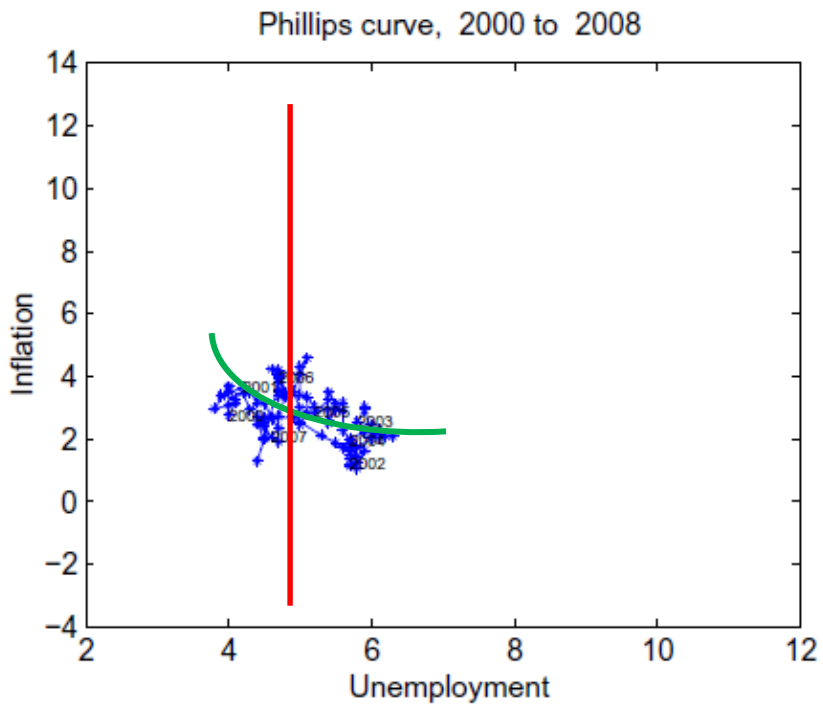


Stable Inflation in the 1990s and 2000

- Central banks do not try anymore to exploit the short-run Phillips curve trade-off, but focus on stabilizing inflation around some inflation target π^*.
- Long-term inflation expectations are anchored at π^*, leading to very stable inflation rates
- The NAIRU decreased during the 1990s due to high productivity gains (IT, Internet, …)

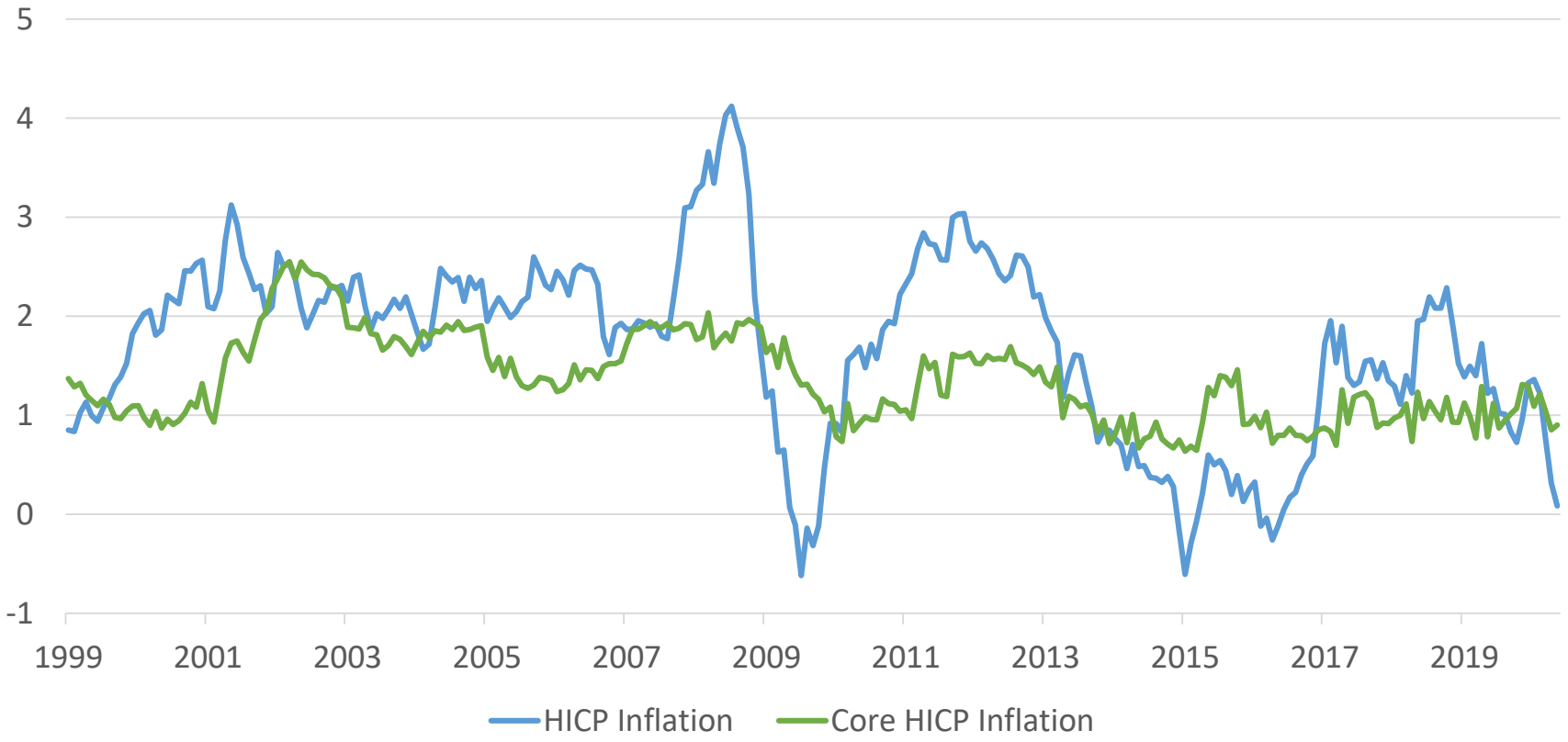
$$\pi_t = \pi^* - \alpha(u_t - u_n)$$



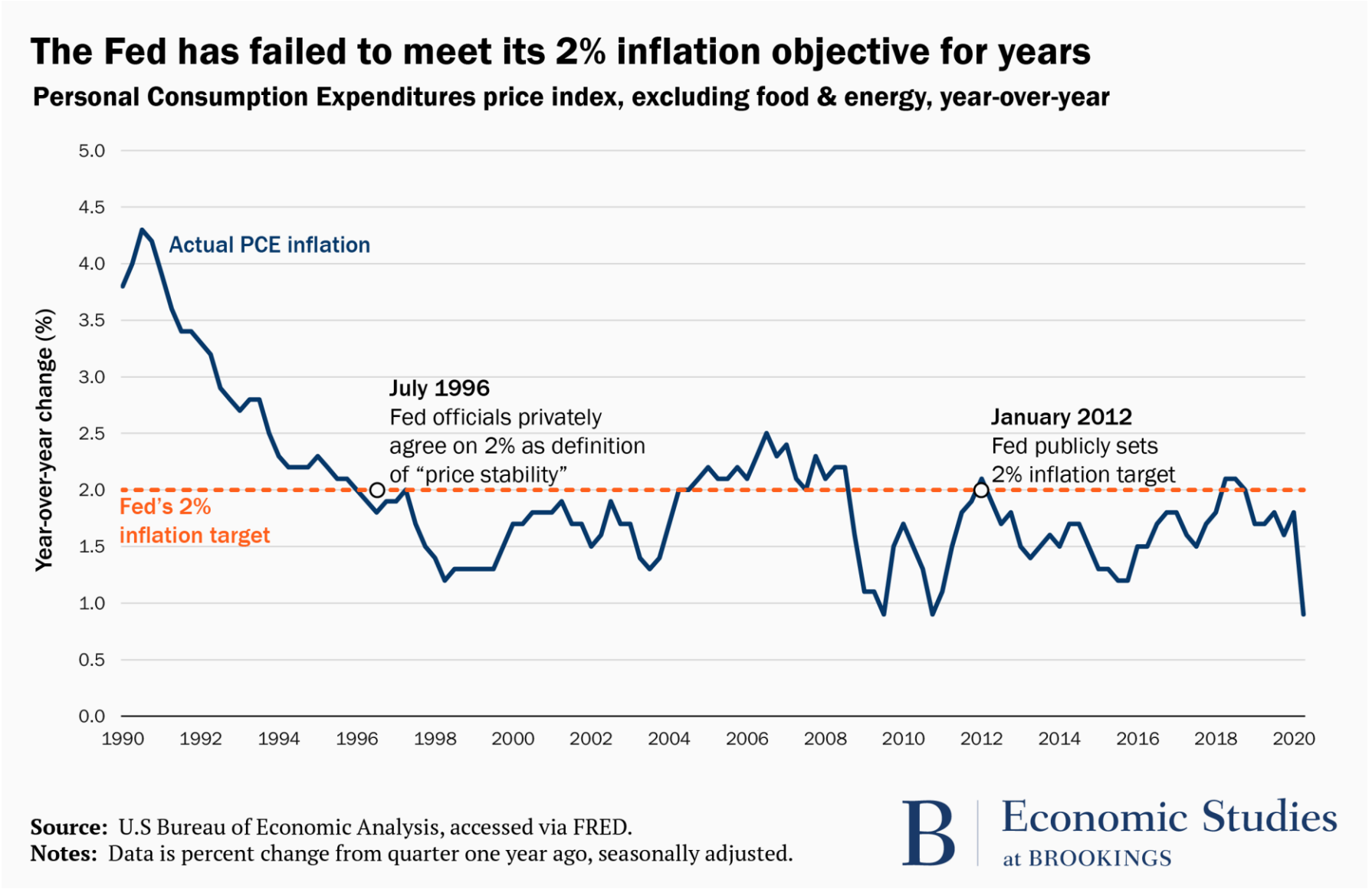


Inflation Below Target Since the Global Financial Crisis

- We will study later in detail the most recent episode, during which the zero lower bound makes it difficult for central banks to stabilize inflation around the inflation target.
- Inflation is has been persistently below target (euro area, but also US), leading to a downward adjustment of long-term inflation expectations.
- Average headline (core) inflation euro area inflation 2008-2021: 1.4% (0.7%)

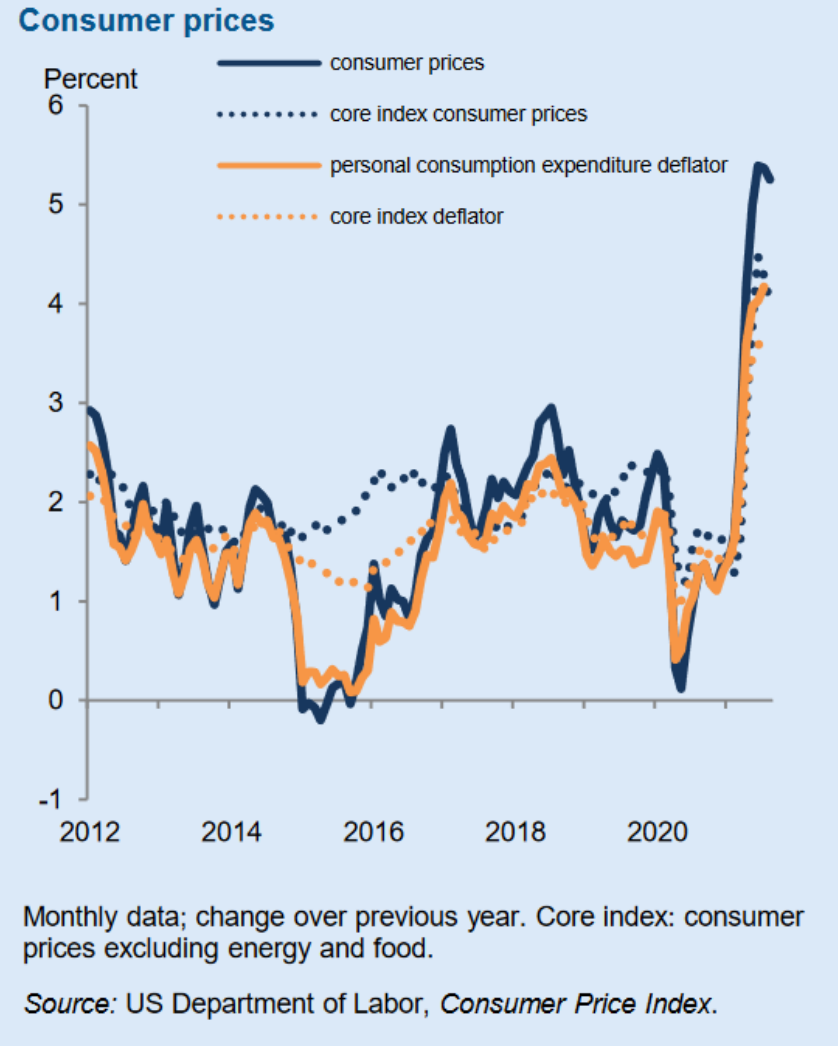


Inflation Below Target Since the Global Financial Crisis

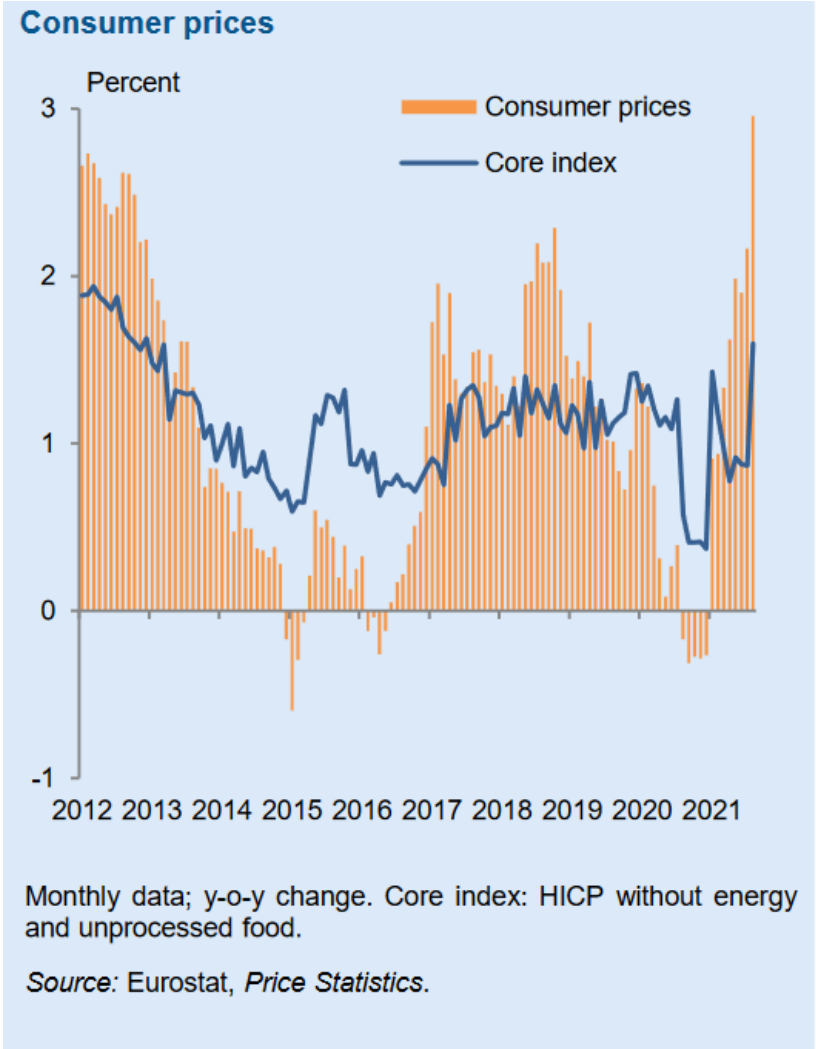


Most Recently Large Increase in Inflation. Is it Temporary?

U.S.



Euro Area

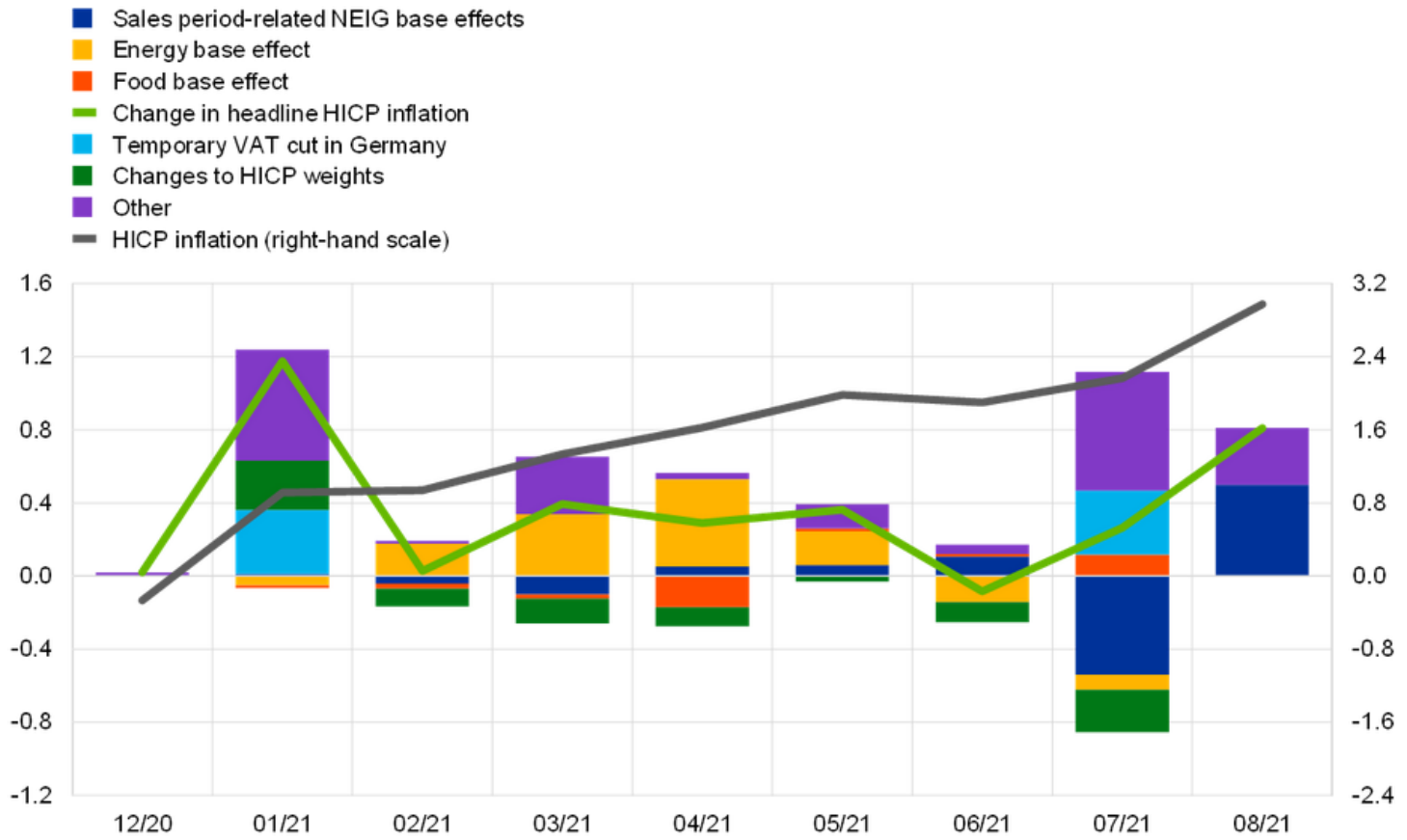


Source: Kieler Konjunkturberichte für Deutschland, den Euroraum und die Welt, 09/2021

Most Recently Large Increase in Inflation. Is it Temporary?

Contributions of base effects and other temporary factors to monthly changes in annual HICP inflation

(percentage point changes and contributions)



Sources: Eurostat, Deutsche Bundesbank, September NIPE and ECB calculations.

Source: ECB, Monthly Bulletin, 09/2021, Charts 14 and 15

Model Element One: The Phillips Curve

We will focus on a version of the Phillips curve in terms of the output gap rather than the unemployment gap:

$$\pi_t = \pi_t^e + \gamma\,(y_t - y^*) + \varepsilon_t^\pi \quad , \quad \gamma > 0$$

It can be derived from a profit maximization problem of firms with price-setting power and nominal rigidities that prevent prices from being fully flexible. The Phillips curve therefore represents the supply side of the economy.

It contains 3 elements:

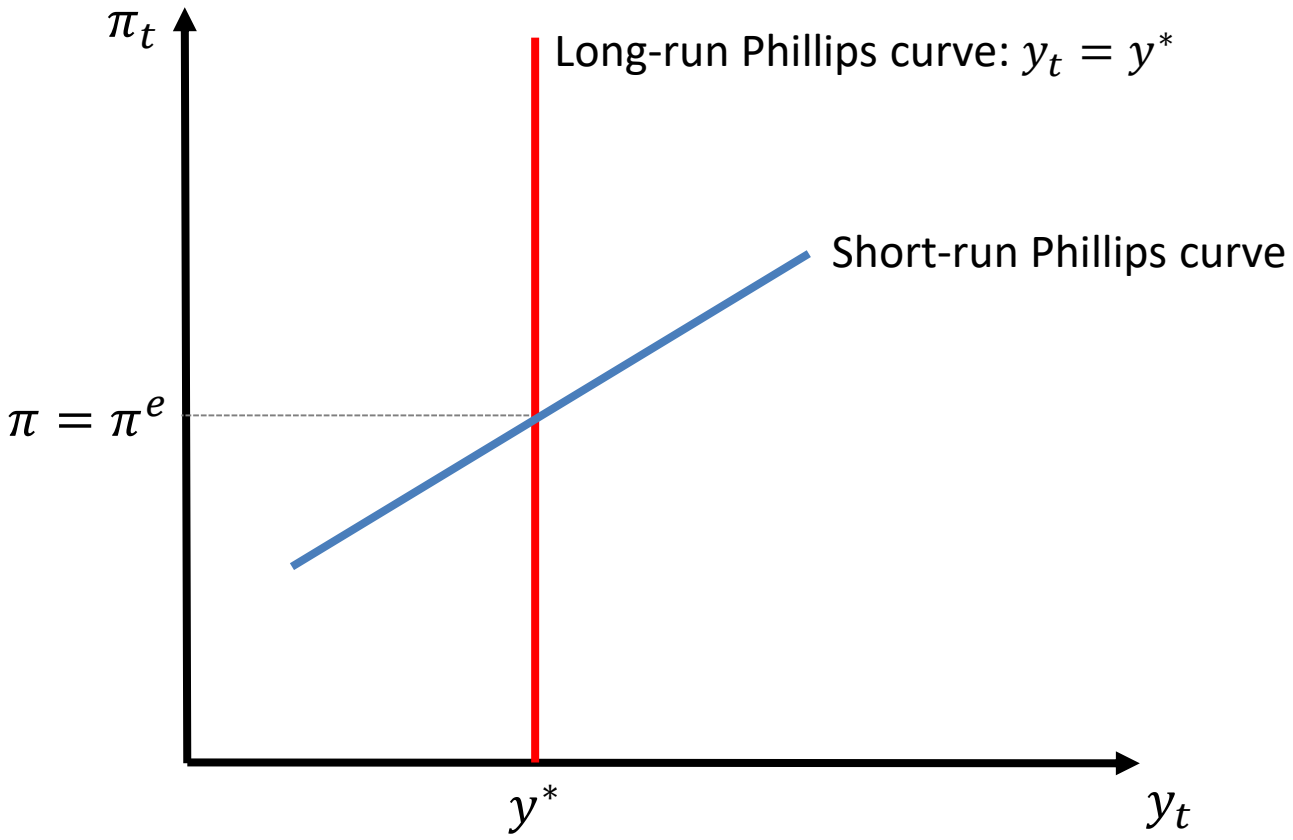
1. Inflation expectations: π_t^e. An increase shifts the Phillips curve upwards. Intuition: Higher expected prices lead to higher wages (recall WS-curve), which in turn is passed into price setting. In the long run $\pi_t = \pi_t^e$, so that the long-run Phillips curve is vertical: $y_t = y^*$.

2. Output gap: $y_t - y^*$. Potential output y^* is consistent with the NAIRU. An increase in the output gap ($y_t > y^*$) leads to an increase in inflation by γ, which is the slope of the Phillips curve. It has decreased over the last decades.

3. Inflation shocks: ε_t^π. It captures all factors beyond inflation expectations and the output gap that drive inflation. Examples are oil price shocks or changes in the mark-up of price-setters.

Model Element One: The Phillips Curve

$$\pi_t = \pi_t^e + \gamma\,(y_t - y^*) + \varepsilon_t^{\pi} \quad , \quad \gamma > 0$$



4.2 Aggregate Demand and the IS-Curve

Components of GDP: Y = C + I + G + EX - IM

Consumption

- The largest component of GDP.
- Less volatile than GDP as it includes non-durable goods like groceries and clothing and services (medical treatment, lawyers, dry cleaning …).
- Includes also durable consumption that are more volatile (ex. washing machines, refrigerators, cars) that in some models are modelled as investment.
- Services have grown substantially in advanced economies over the last 60 years.

Investment

- Much more volatile than consumption.
- Business investments: goods that are used in the production process. Examples: construction of new offices and factories, the purchase of machinery, computers, other equipment used to assist labor in the production of goods and services.
- Residential investment: Actual construction of housing, not the sale of homes.
- Changes in inventories (difference between production and sales): goods held in inventories are counted for the year produced, not the year sold

Components of GDP: Y = C + I + G + EX - IM

Government Spending

- Goods and services bought by government. Includes salaries of public sector employees. Excludes transfers like social security payment and unemployment insurance.

Exports

- Goods and services produced domestically, but sold abroad.

Imports

- The definition of GDP states that it is about goods and services produced within an economy. Hence, all goods and services in consumption, investment and government spending bought from abroad must be deducted.

Consumption Demand

Keynesian consumption function

$$C_t = c_0 + c_1(Y - T)$$

c_0: autonomous consumption

c_1: marginal propensity to consume

T: lump-sum tax (with proportional tax: $C_t = c_0 + c_1(1 - t)Y$)

- Households are not forward looking, so consumption depends only on current disposable income.
- Under the assumption that output is elastic in the short run (for example via using inventories, working over time etc.) this leads to a large multiplier (plug consumption function in $Y = C + I + G$ and solve for Y):

$$Y_t = \frac{1}{1 - c_1}(c_0 - c_1 T + I + G)$$

- Keynes was aware that the real interest rate might also play a role for consumption savings decision, but he thought that income is so much more important.
- As households are not forward looking, the fact that an increase in current government spending might lead to higher taxes in the future is disregarded by households. This means Ricardian equivalence does not hold (Ricardian equivalence: households would save more today if they expect taxes to go up in the future)

Consumption Demand

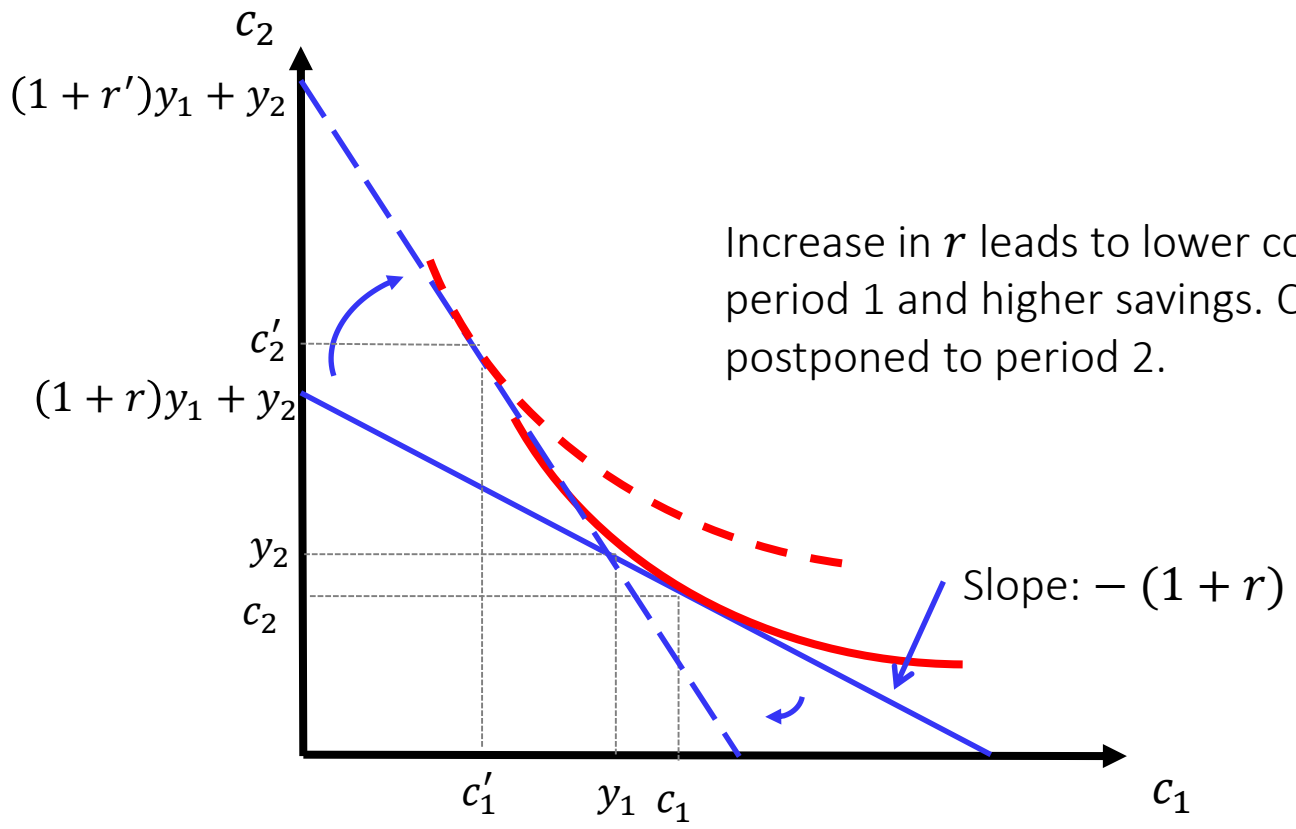
Neoclassical / New Keynesian consumption function

$$C_t = C^d(\underbrace{Y_t}_{+}, \underbrace{Y_{t+1}}_{+}, \underbrace{r_t}_{-})$$

- Can be derived from a consumption-saving problem of households: Maximize a utility function subject to an intertemporal budget constraint
- With a concave utility function, households have a consumption smoothing motive. Households prefer to have smooth rather than fluctuating consumption, which means they need to save and borrow (life-cycle motive). Expectations about future income matter.
- An increase in current income Y_t leads to an increase in consumption, but less than one-to-one because part of the additional income is saved for future consumption (consumption smoothing). The marginal propensity to consume is therefore lower than 1.
- An expected increase in future income Y_{t+1}, would increase consumption already today, due to the consumption smoothing motive. This effect might be limited in case of credit constraints.
- An increase in the real interest rate r_t increases savings and lowers consumption.

Increase in the Real Interest Rate

- What happens if the central bank increases the interest rate?
- Assume that prices are fixed in the *short-term* so that a change in the nominal interest rate leads to a change in the real interest rate ($i = r + \bar{\pi}$).
- Main transmission mechanism of monetary policy in New Keynesian models: *intertemporal substitution of consumption*.



Increase in r leads to lower consumption in period 1 and higher savings. Consumption is postponed to period 2.

Investment Demand

Investment depends negatively on the real interest rate

$$I_t = I^d(\underbrace{r_t}_{-}) = a_0 - a_1 r_t$$

a_0: capture future expected post-tax profits from investment

a_1: interest rate elasticity

- Intuitively: An increase in r_t increases the financing cost of investment, so that less profitable investments are disregarded.
- Formally: Recall the capital/investment demand equation that we have derived in lecture 2 (Solow model, perfect competition). Capital is accumulated up to the point where the marginal product of capital equals the return to capital ($\approx r_t$). If r_t increases, the demand for capital decreases (which leads to an increase in the marginal product of capital) until equality is preserved: $r_t = MPK$
- Other factors might also have some influence, but are omitted here for simplicity:
  - Investment demand would increase with labor input and with an expected increase in future technology (both increase MPK)
  - Risk premia might increase financing cost and lower investment. One can interpret r_t as being the sum of the risk-free real interest rate and the risk premium.

Model Element Two: IS-Curve

We will treat government spending as exogenous and ignore exports and imports.

The IS equation summarizes the demand side of the economy.

- It show that output (in deviations from potential output) depends negatively on the real interest rate (recall $r_t \approx i_t - \pi_t$).
- This negative relation is caused by the negative dependence of investment and consumption on the real interest rate.

Our version of the IS curve will be the following:

$$y_t = y_t^* - \alpha(\underbrace{i_t - \pi_t}_{r_t} - r^*) + \varepsilon_t^y, \quad \alpha > 0$$

Model Element Two: IS-Curve

IS curve:

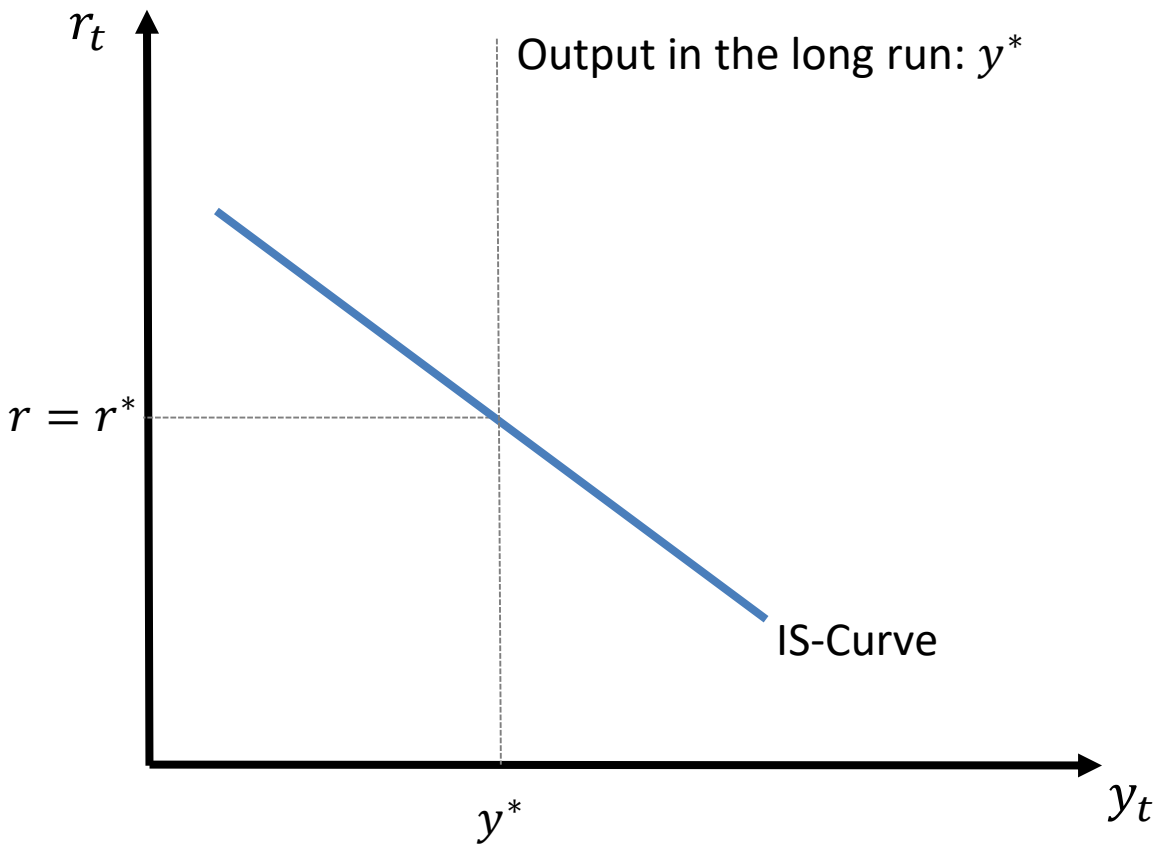
$$y_t = y_t^* - \alpha(\underbrace{i_t - \pi_t}_{r_t} - r^*) + \varepsilon_t^y, \quad \alpha > 0$$

The IS-equation contains 2 elements:

1. The real interest rate $r_t \approx i_t - \pi_t$. An increase increases financing costs, which lowers investment and increases the desire to save, thereby lowering consumption.
2. Demand shock ε_t^y captures changes in all other factors that influence aggregate spending decisions. Examples: fiscal policy, asset prices and consumer and business sentiment.

- It is a slightly simplified version of the IS equation of the New Keynesian model that in addition includes expected future deviations of output from potential output due to the forward-looking consumption-saving decision of households.
- In the long run output equals potential output and in this case the interest rate equals the natural interest rate r^*. Monetary policy can affect demand temporarily via inducing deviations of the real interest rate from the natural interest rate. In the medium to long run the economy will return to potential output.

Model Element Two: IS-Curve

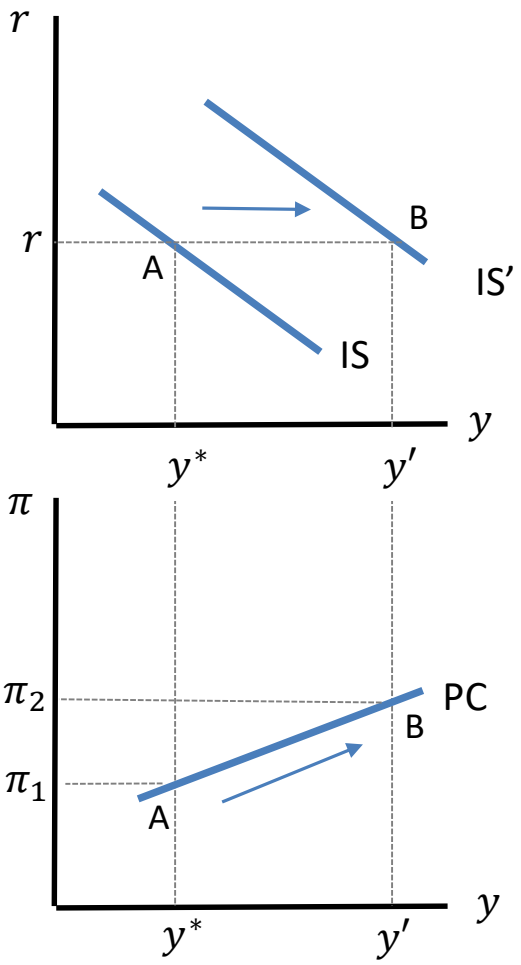


- We have so far two equations in the model, but three variables: π_t, y_t, i_t
- Let's assume for now that i_t is set exogenously by the central bank

4.3 Demand and Supply Shocks in the IS-PC Model

An Aggregate Demand Shock

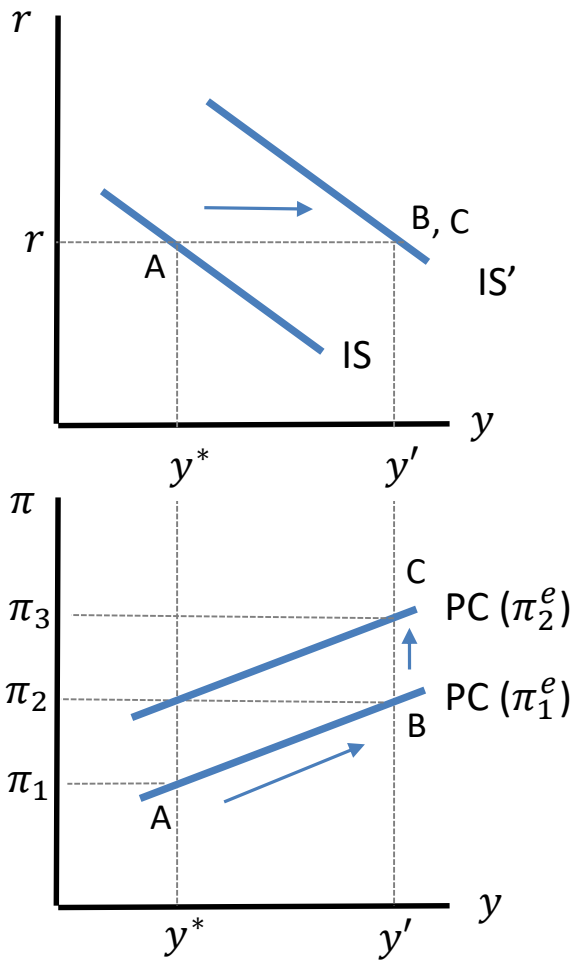
$$\pi_t = \pi_t^e + \gamma\,(y_t - y^*) + \varepsilon_t^{\pi} \qquad y_t = y_t^* - \alpha(r_t - r^*) + \varepsilon_t^{y}$$



- $\varepsilon_t^y > 0$ moves the IS-curve to the right.
- Given a fixed real interest rate (assume that the central bank adjusts i_t, so that r_t remains fixed), output moves above potential output.
- This leads to an increase in inflation above expected inflation ($\pi_2 > \pi_1^e$) via the Phillips curve. The economy moves from A to B.
- Further dynamics will differ depending on:
  - Inflation expectations are anchored or not
  - Central bank adjusts the real rate
  - Shock is permanent or temporary

An Aggregate Demand Shock

$$\pi_t = \pi_t^e + \gamma\,(y_t - y^*) + \varepsilon_t^{\pi} \qquad y_t = y_t^* - \alpha(r_t - r^*) + \varepsilon_t^{y}$$

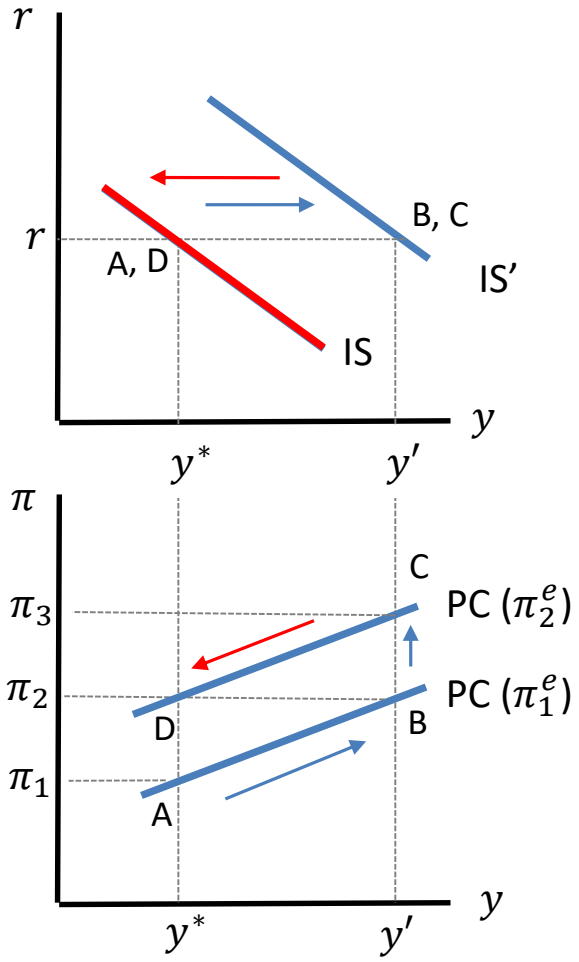


Scenario 1: inflation expectations are not firmly anchored, the central bank leaves the real interest rate unchanged and it is a permanent shock.

- After a while people realize that inflation is permanently higher ($\pi_2 > \pi_1$) and adjust inflation expectations upwards to π_2^e (example: adaptive expectations: $\pi^e = \pi_{t-1}$).
- This moves the Phillips curve upwards, further increasing inflation to π_3. The economy moves to point C.
- Without stabilization by the central bank (increase in r) or fading out of the demand shock, this will result in further increases in π^e, further pushing up the Phillips curve, increasing π, increasing in π^e, …

An Aggregate Demand Shock

$$\pi_t = \pi_t^e + \gamma\,(y_t - y^*) + \varepsilon_t^{\pi} \qquad y_t = y_t^* - \alpha(r_t - r^*) + \varepsilon_t^{y}$$

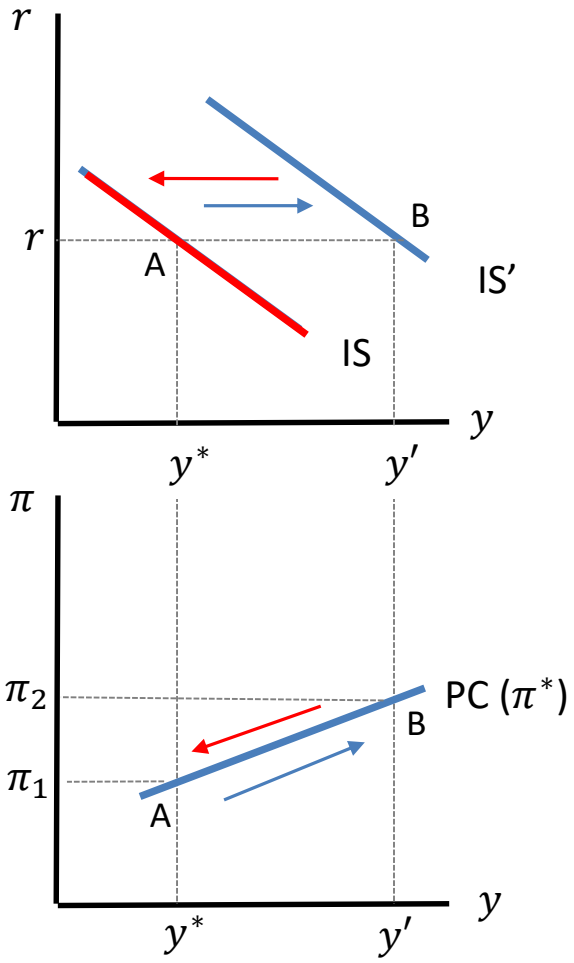


Scenario 2: start from the previous scenario when the economy is in point C, but assume now that the demand shock is temporary and it fades out at this point in time.

- The IS curve moves back. Output goes back to potential output.
- Inflation moves down on the Phillips curve until $y^* = y$ and $\pi_2 = \pi_2^e$. The economy moves to point D.
- Inflation is now higher than before. It would need a negative IS shock or an increase in r generated by the central bank to shift the IS curve for a while to the left in order to move the Phillips curve to its original location and bringing inflation back down to π_1.

An Aggregate Demand Shock

$$\pi_t = \pi^* + \gamma\,(y_t - y^*) + \varepsilon_t^{\pi} \qquad y_t = y_t^* - \alpha(r_t - r^*) + \varepsilon_t^{y}$$

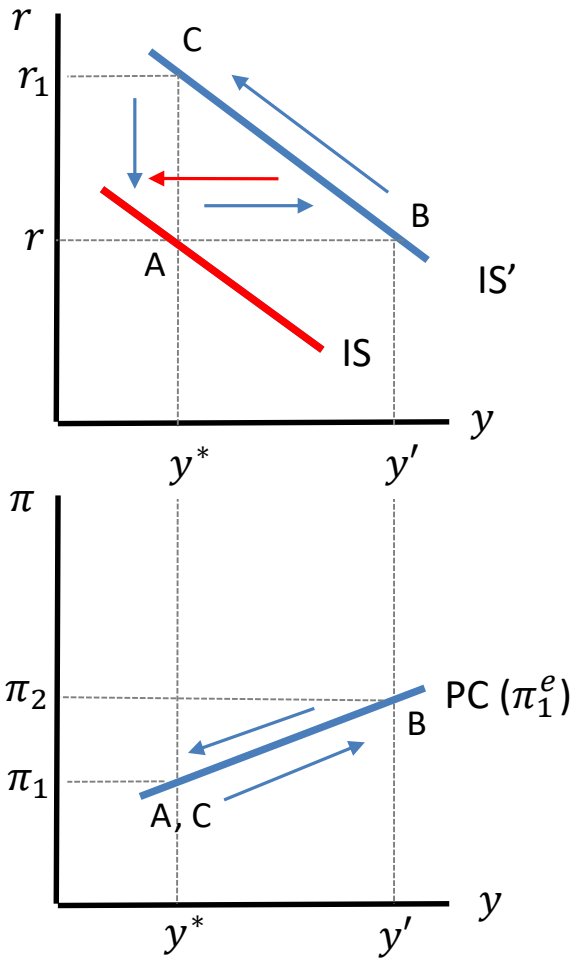


Scenario 3: inflation expectations are firmly anchored at an inflation target ($\pi^e = \pi^*$), the central bank leaves the real interest rate unchanged and it is a temporary shock.

- People do not readjust inflation expectations as they trust that the central bank will increase r if the shock does not fade out soon enough. Hence, the Phillips curve does not move upwards, but the economy remains in point B.
- Let's assume that at this point in time the demand shock fades out and the IS curve moves back. Output goes back to potential output.
- Inflation moves down on PC (π^*) until $y^* = y$ and $\pi = \pi^*$. The economy has moved back to point A.
- Inflation is where it was originally. The high reputation of the central bank has prevented a permanent increase in inflation.

An Aggregate Demand Shock

$$\pi_t = \pi_t^e + \gamma\,(y_t - y^*) + \varepsilon_t^{\pi} \qquad y_t = y_t^* - \alpha(r_t - r^*) + \varepsilon_t^{y}$$

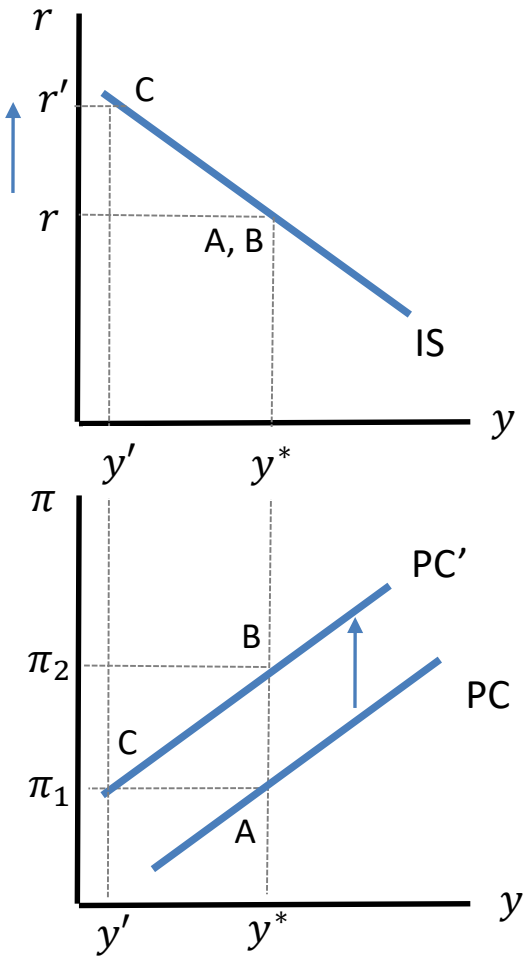


Scenario 4: inflation expectations are not firmly anchored, the central bank adjusts the interest rate and the shock fades out after a while.

- Before inflation expectations adjust upwards, the central bank increases r to r_1, output moves back to y^*. Inflation moves back to π_1. The economy is in point C.
- After a while, the shock fades out. The IS-curve moves back. To avoid a huge recession (moving to the left on IS'), the central bank needs to lower r to its original value. In doing so inflation remains at π_1. The economy is back in point A.
- The result achieved is the same as under Scenario 3. However, here the timing of central bank actions is crucial and the assumption that the shock can be directly observed.

An Aggregate Supply Shock

$$\pi_t = \pi_t^e + \gamma\,(y_t - y^*) + \varepsilon_t^{\pi} \qquad y_t = y_t^* - \alpha(r_t - r^*) + \varepsilon_t^{y}$$



- $\varepsilon_t^{\pi} > 0$ moves the PC-curve upwards. Example: Increase in energy prices.
- Inflation increases to π_2. The economy moves to point B.
- The IS curve is not affected as long as the central bank does not change r.
- Let's now assume that the central bank increases r to decrease inflation back to π_1. This comes at the cost of decreasing output to y'. The economy moves to point C.

An Aggregate Supply Shock

The previous analysis shows a crucial difference between the stabilization of demand and supply shocks:

- In response to demand shocks, output and inflation move in the same direction. Stabilizing output implies stabilizing inflation and vice versa.
- In response to supply shocks, there is a trade-off for policy makers. Stabilizing inflation destabilizes output and stabilizing output destabilizes inflation. The policymaker needs to choose which output and inflation combination to target (points between B and C)

Summary

- The Phillips curve represents the supply side of the economy and is just another representation of the AS-curve. We distinguish the short- and long-run Phillips curve.
- In the long run the Phillips curve is vertical, given that inflation expectations adjust to actual inflation. Potential output and the NAIRU are determined by supply-side factors. Inflation is determined by money supply (recall the Quantity Theory)
- In the short run there is a trade-off between output (or unemployment) and inflation.
- These are some of the most important findings in monetary economics. No central bank tries to permanently increase output (decrease unemployment) anymore. Therefore, inflation is low and stable in most economies.

- The IS-curve describes the demand side. Consumption and investment are negatively related to the real interest rate. Other influences can shift the IS curve.
- Regarding monetary policy, we have focused directly on interest rate setting. Note that in reality the central bank has control only over the nominal interest rate.
- The analysis shows that expectations play a key role in modern macroeconomic models (rational expectation revolution started with the Lucas critique). This is clearly seen by the Phillips curve. It is very important for the central bank to anchor inflation expectations.
- Demand shocks move output and inflation in the same direction. The economy can be fully stabilized.
- Supply shocks create a trade-off between stabilizing output or inflation.