Business Cycles

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Introduction

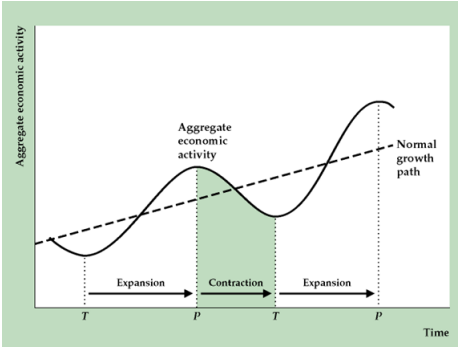
- In this chapter, we move to a more detailed analysis of short-run fluctuations around potential output, using a simpler model.
- We first review what a business cycle is.
- We then document how output, unemployment, and inflation move over the cycle.
- We study how monetary policy works in modern economies.
- Finally, we analyze how government policy can stabilize the economy during a recession.

Business Cycles: Trend and Fluctuations

- Output fluctuates around a long-run trend
- Deviations from trend are business cycles

- **Expansion:**
  - Output rising
  - From trough to peak

- **Contraction:**
  - Output falling
  - From peak to trough



Trend and Cycle

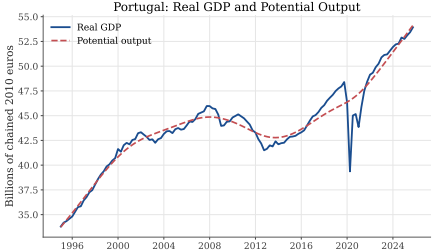
- Useful to decompose output into:
  - A long-run trend
  - Short-run fluctuations (the cycle)
- Trend output is often called:
  - **Potential output**
  - **Natural rate of output**
- Denote potential output by Y_t^*
- Define the **output gap** as:

$$\tilde{Y}_t = \frac{Y_t - Y_t^*}{Y_t^*} \approx \ell \mathrm{n} \left(\frac{Y_t}{Y_t^*} \right)$$

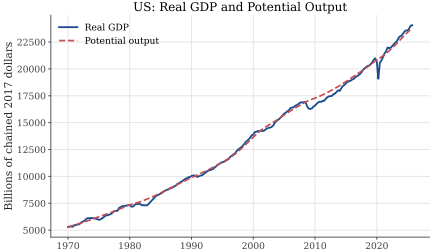
The Trend: Potential Output

- Real GDP fluctuates around potential output
- Potential output is typically estimated, not directly observed
- The gap between the two:
  - Appears small relative to long-run growth
  - Corresponds to booms and recessions

The Trend: Potential Output



Source: Eurostat via FRED (CLVMNACSCAB1GQPT). Potential output is an HP-filter trend.

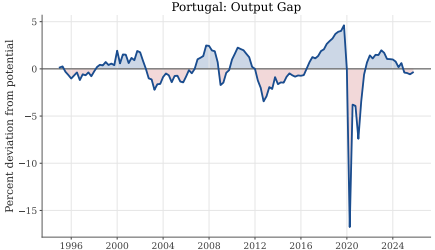


Source: BEA and CBO via FRED (GDPC1, GDPPOT).

The Business Cycle

- If we look at the output gap measured as the difference between log output and log potential output
  - Recessions can cause up to 10% fall in output relative to potential
  - Corresponds to booms and recessions
- During deep recessions, the loss of output can be very large.
- The cost is unevenly distributed across regions, firms, and occupations.
- Workers and firms directly hit by the recession bear much larger losses.

The Business Cycle



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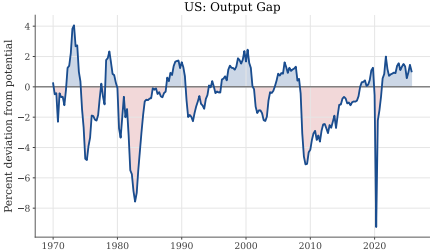
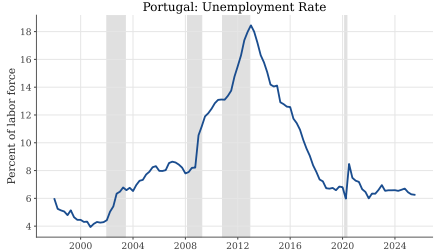


Source: BEA and CBO via FRED (GDPC1, GDPPOT).

Unemployment

- Recessions are not only periods of low output.
- They are also periods in which many workers lose jobs or cannot find work.
- Unemployment tends to rise when output falls below potential.
- The size and persistence of unemployment increases differ across countries and recessions.

Unemployment



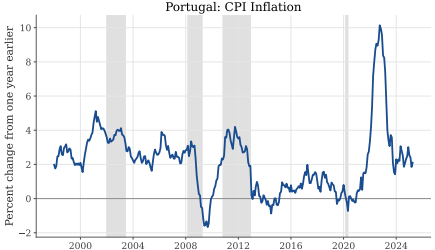
Source: OECD via FRED (LRUN64TTPTQ156S). Gray bars: OECD recessions via FRED (PRTREC).

Source: BLS via FRED (UNRATE). Gray bars: NBER recessions via FRED (USREC).

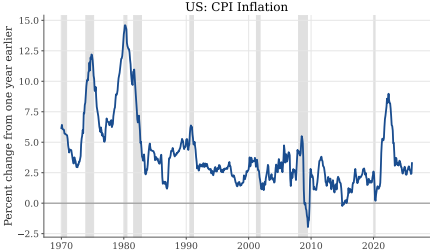
Inflation

- Business cycles are also associated with movements in inflation.
- When demand is strong and output is above potential, inflation tends to rise.
- When demand is weak and output is below potential, inflationary pressure tends to fall.

Inflation



Source: OECD via FRED (PRTCPIALLMINMEI). Gray bars: OECD recessions via FRED (PRTREC).



Source: BLS via FRED (CPIAUCSL). Gray bars: NBER recessions via FRED (USREC).

Overview of the Short-Run Model

- In this chapter, we build a simple model of short-run fluctuations around potential output.
- The central variable is the **output gap**:

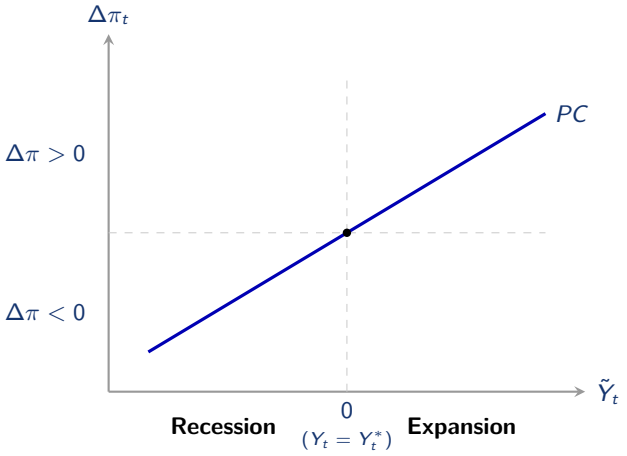
$$\tilde{Y}_t = \frac{Y_t - Y_t^*}{Y_t^*}$$

- The output gap affects two key macroeconomic outcomes:
  - **Inflation**, through the Phillips curve
  - **Unemployment**, through Okun's Law
- We first study these two relationships, and then use the model to analyze monetary and fiscal policy.

The Phillips Curve

- This dynamic trade-off is known as the **Phillips curve**
- Named after Bill Phillips (1958)
- The Phillips curve relates:
  - The output gap $\tilde{Y}_t$
  - Changes in the inflation rate $\Delta\pi_t$

The Phillips Curve

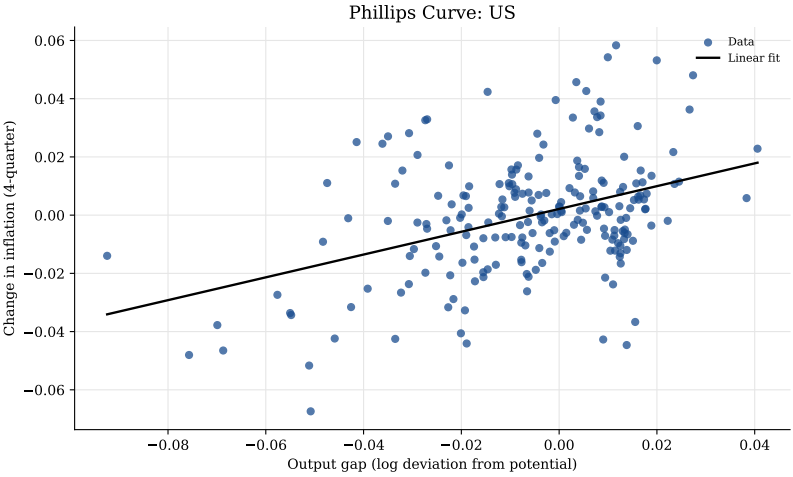


Why Inflation Rises in a Boom

- We already saw from the price-setting equation of the previous chapter that when output is above potential, firms raise prices.
- The idea is that firms can temporarily produce more than potential output
- They do so by:
  - Asking workers to put in overtime
  - Paying higher wages
  - Delaying maintenance and other costs
- These measures allow higher output in the short run.
- But they raise costs and cannot be sustained forever.
- Firms raise prices because production is more costly and goods are scarce.

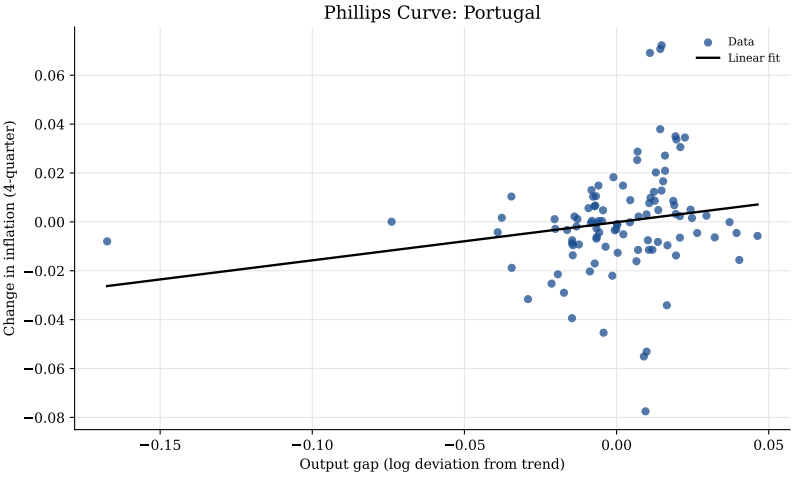
The Phillips Curve

US data



The Phillips Curve

Portuguese data



Okun's Law: Output and Unemployment

- When analyzing economic fluctuations, we can focus on either output or unemployment.
- A **recession** occurs when output is below potential and unemployment is high; a boom occurs when output is above potential and unemployment is low.
- For simplicity, in the this chapter, we will focus on output.
- There is a way to move between output and unemployment analysis: Okun's Law.

Okun's Law: Quantitative Relationship

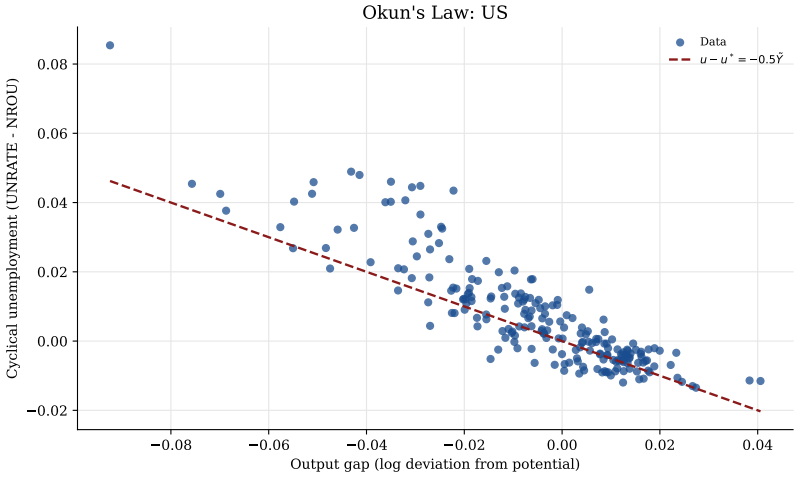
- The relationship can be summarized as:

$$u_t - u^* \approx -\frac{1}{2}\tilde{Y}_t,$$

  where u_t is the unemployment rate and u^* is the natural rate of unemployment
- Interpretation:
  - For each 1% output below potential, unemployment exceeds its natural rate by 0.5%.
  - Example: In 2009, U.S. output was 7% below potential $\Longrightarrow$ unemployment was about 3.5 percentage points above u^*.
- Okun's Law allows us to **connect output fluctuations to unemployment**.

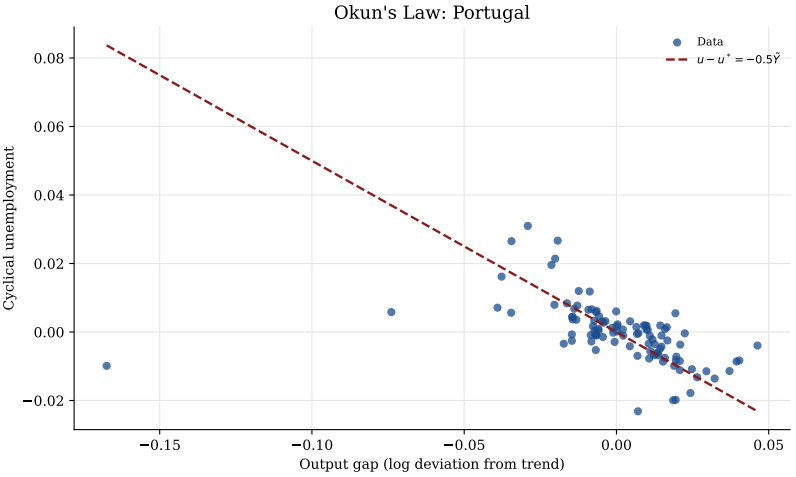
Okun's Law

US data



Okun's Law

Portuguese data



From Money to Monetary Policy

- Before explaining the short-run model, we need to understand how central banks conduct monetary policy.
- In the money chapter, we saw that central banks control the monetary base by buying and selling bonds from commercial banks.
  - central banks use open market operations to buy or sell bonds
  - this changes the monetary base and can affect **M1** through bank lending
- In this chapter we shift from money quantities to interest rates.
  - Modern central banks implement monetay policy by setting the interest on reserves at which banks borrow and lend.
- Why the change?
  - After the financial crisis, regulation became more focused on bank liquidity rather than reserve requirements.
  - Banks accumulated abundant reserves, so reserve supply is less useful as a precise policy instrument.
  - Central banks can guide market rates more directly by setting the return on reserves.

Why Banks Need Reserves

- With no reserve requirements, why do banks need reserves at all?
- First, banks need central bank reserves to settle payments with each other.
  - If an Activo customer pays a Santander customer, deposits move from Activo to Santander.
  - Activo then settles with Santander by transferring reserves at the central bank.
- Second, reserves are the most liquid asset banks can use to meet withdrawals or unexpected payment outflows.
- Reserves are therefore both:
  - the final means of payment between banks
  - part of banks' liquidity buffer
- At the end of the day, some banks may have more reserves than they want to hold, while others may need reserves for settlement or liquidity.

How Central Banks Control Interest Rates

- Banks with surplus reserves can lend them overnight to banks that need reserves.
- The central bank controls this market by setting the rates at which banks can borrow from it or deposit reserves with it.

$$\text{deposit rate} \leq \text{overnight market rate} \leq \text{lending rate}$$

- If the market rate is too high, banks borrow from the central bank instead.
- If the market rate is too low, banks deposit reserves at the central bank instead.
- These arbitrage forces keep the overnight market rate close to the central bank's policy rate.

Controlling Interest Rates: Example

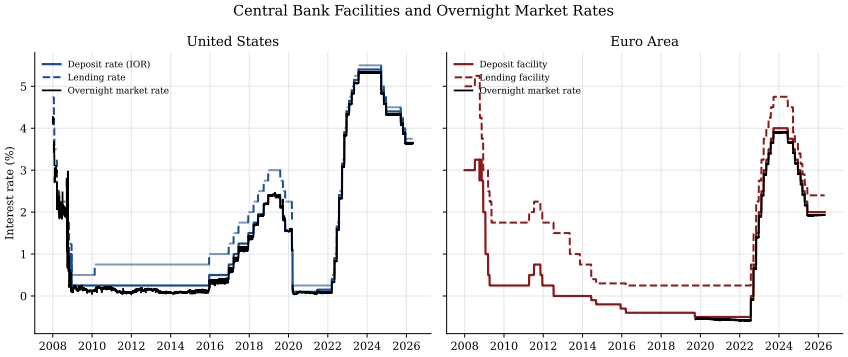
- Suppose the central bank sets:

$$\text{deposit rate} = 3\%, \qquad \text{lending rate} = 5\%$$

- If the overnight market rate were 6%:
  - banks needing reserves would borrow from the central bank at 5%
  - no bank would borrow in the market at 6%
- If the overnight market rate were 2%:
  - banks with surplus reserves would deposit at the central bank at 3%
  - no bank would lend in the market at 2%
- Therefore, arbitrage keeps the overnight rate between 3% and 5%.

Policy Rates

US and Europe



Monetary Policy

How interest rates affect spending

- When the central bank raises the policy rate, banks and financial markets pass this through to other interest rates.
- Business loans, mortgages, and consumer credit become more expensive.
- Firms reduce investment, and households reduce interest-sensitive consumption.

$$\uparrow R_t \quad \Rightarrow \quad \downarrow I_t, \downarrow C_t \quad \Rightarrow \quad \downarrow \tilde{Y}_t$$

Defining the Short-Run Model

- We now have an idea of how the different blocks of the model work:
  - the output gap affects inflation through the Phillips curve
  - the output gap affects unemployment through Okun's Law
- Now let's define the model.
- The model has two main parts:
  - **IS curve**: **Investment-Saving** curve
  - **MP curve**: **Monetary Policy** curve
- We cover first the IS curve and then the MP curve.

The IS Curve

GDP Expenditure Approach:

$$Y_t = C_t + I_t + G_t + EX_t - IM_t$$

- Output Y_t can be used for:
  - Consumption C_t
  - Investment I_t
  - Government purchases G_t
  - Net exports $EX_t - IM_t$
- In a closed economy with no government expenditure, this simpifies to:

$$Y_t = C_t + I_t$$

The IS Curve

The next two equations explain how each use of output is determined:

$$C_t = a_c Y_t^*$$

$$\frac{I_t}{Y_t^*} = a_i - b(R_t - r^*)$$

- The first equation equations just states that consumption is a constant fraction of potential output.
- Investment is special: depends negatively on the real interest rate R_t, reflecting the short-run model emphasis on investment.

The IS Curve

- In the short run, potential output Y_t^* is assumed exogenous.

Consumption:

$$C_t = a_c Y_t^*$$

- $a_c \approx 2/3$: roughly 2 out of 3 dollars of GDP go toward consumption.
- Economic intuition: agents consume a constant fraction of potential output.
- Because potential output is smoother than actual output, consumption is smoother than actual GDP.

The Investment Equation

- Long-run share of output: a_i is the fraction of potential output devoted to investment if interest rates equal the marginal product of capital.
- Interest rate effect: Investment depends on the gap between the real interest rate R_t and the marginal product of capital r:

$$\frac{I_t}{Y_t^*} = a_i - b(R_t - r^*)$$

- If $R_t < r^*$, investment is more profitable: firms borrow + and invest +.
- If $R_t > r^*$, investment is less attractive: firms may save instead of investing.

Deriving the IS Curve

Start from the GDP identity:

$$Y_t = C_t + I_t$$

Substitute the previous equations:

$$C_t = a_c Y_t^*, \quad I_t / Y_t^* = a_i - b(R_t - r),$$

Combine terms and subtract 1:

$$\frac{Y_t}{Y_t^*} - 1 = a_c + a_i - 1 - b(R_t - r)$$

Define short-run output gap:

$$\tilde{Y}_t = a - b(R_t - r^*), \quad a \equiv a_c + a_i - 1$$

$\Rightarrow$ IS curve: downward-sloping line relating short-run output gap to the interest rate.

The IS Curve

$$\tilde{Y}_t = a - b(R_t - r^*)$$

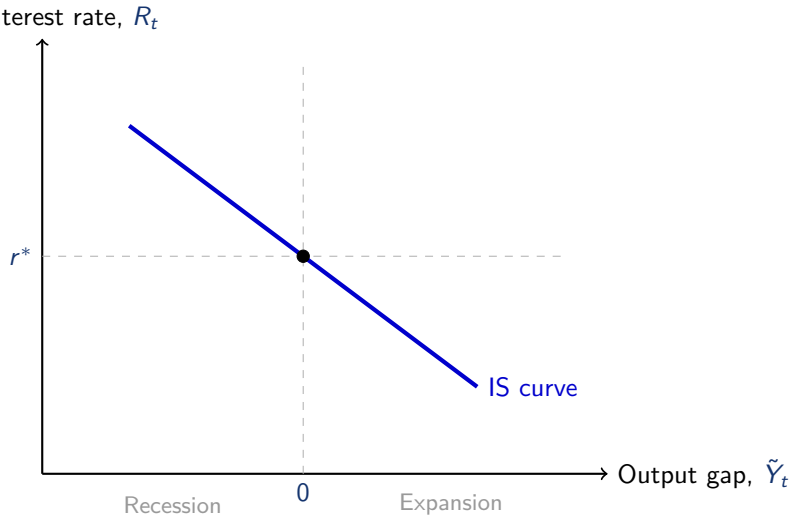
- The a parameter is a combination of the consumption and investment shares of potential output capturing aggregate demand shocks.
- Consider the case where the economy has settled down at its long- run values:

$$Y_t = Y_t^* \Leftrightarrow \tilde{Y}_t = 0$$
$$R_t = r^*$$
$$\tilde{Y}_t = a - b(R_t - r^*) = a - b(0) = 0 \Leftrightarrow a = 0$$

- In our baseline model, we will assume $a = 0$, so that the IS curve passes through the origin.
- b is the slope of the IS curve, which captures how sensitive investment is to changes in the real interest rate.

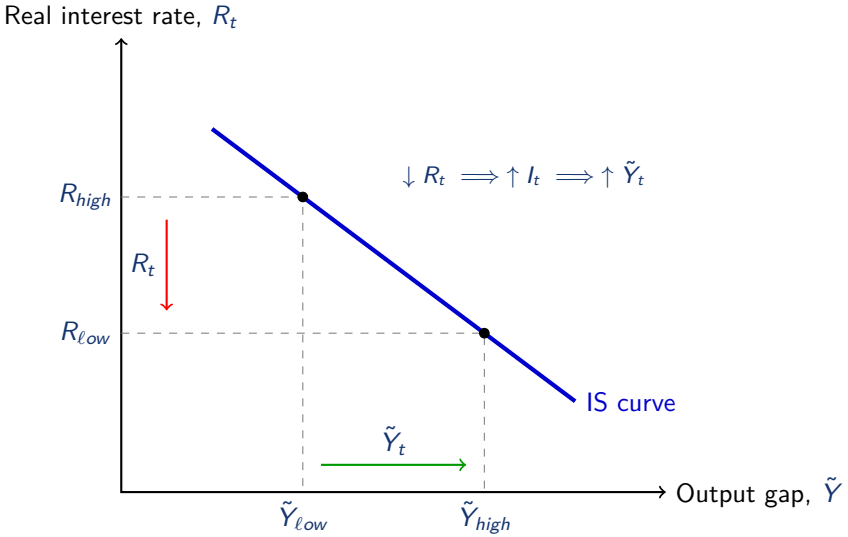
The IS Curve

Baseline Case



The IS Curve

Decrease in the Interest Rate



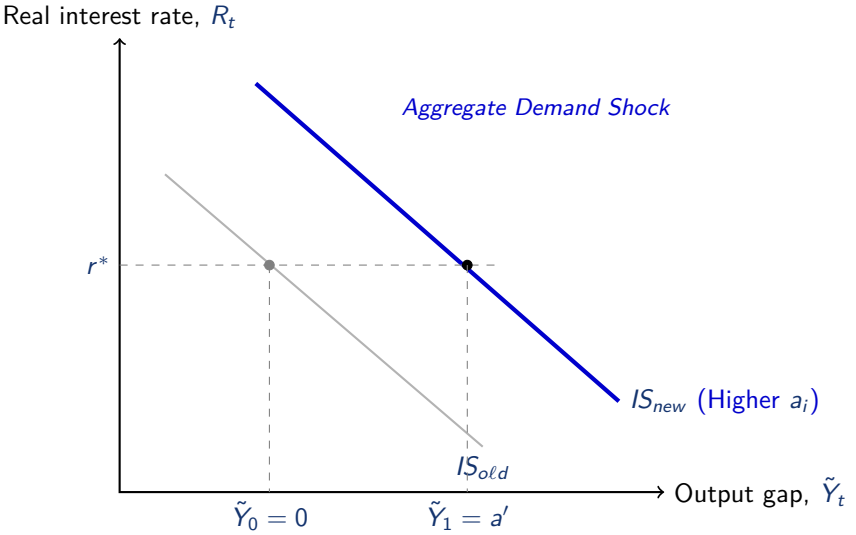
An Aggregate Demand Shock

- Suppose firms become more optimistic about future demand or profitability.
- At any given real interest rate, firms increase investment spending.
- In the IS framework, this corresponds to an increase in a_i (the investment share of potential output).
- How does the IS curve respond?
  - The aggregate demand parameter a rises to some value $a' > a$.
  - For any given real interest rate R_t, output $\tilde{Y}_t$ is higher.
  - This is not a movement along the IS curve, but a rightward shift of the IS curve.

$$\tilde{Y}_t = a - b(R_t - r^*)$$

The IS Curve

Aggregate Shock



The MP Curve: Monetary Policy

- So far, we treated the real interest rate R_t as exogenous in the IS curve.
- In reality, the central bank chooses the short-term nominal interest rate to influence the economy:
  - In the US: the federal funds rate set by the Federal Reserve.
  - In the euro area: key ECB rates (e.g. the Deposit facility rate).
- The **MP curve** shows how the central bank's policy rate determines the real interest rate in the short run.

From Nominal to Real Interest Rates

The Fisher Equation

- The Fisher equation links nominal and real rates:

$$i_t = R_t + \pi_t \quad \Rightarrow \quad R_t = i_t - \pi_t$$

- A change in the nominal rate affects the real interest rate as long as inflation does not adjust immediately.
- As we did in the previous chapter, we assume **sticky prices** in the short run
  - Prices (and thus inflation) responds slowly to changes in the nominal interest rate.
- In the very short run (e.g., 6 months), the real interest rate moves roughly one-for-one with the nominal rate.

From Price Setting equations to the Phillips Curve

- Let use a similar price setting equation as the one we had:

$$\pi_t = \pi_t^e + \theta \tilde{Y}_t$$

- We have a new term π_t^e which is the expected inflation rate for period t.
- The intuition is that firms set prices based on their expectations of future inflation.
- Imagine the CEO of a firm is setting prices for the next year. She considers:
  - For each of the past 3 years, the inflation rate has remained steady at 5 percent per year, and GDP has equaled potential output
  - In normal times, $\tilde{Y} = 0$, she expects inflation to remain at 5 percent, so $\pi_t^e = 5\%$ and $\pi_t = 5\%$
  - If in a given year your output falls ($\tilde{Y} < 0$), she might raise prices less than 5% in an effort to boost sales, so $\pi_t < 5\%$.

The Phillips Curve

- Assume firms expect inflation next year to equal inflation last year:

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

  - Inflation is **sticky**
  - Expectations adjust slowly over time

- Combining price setting and expectations:

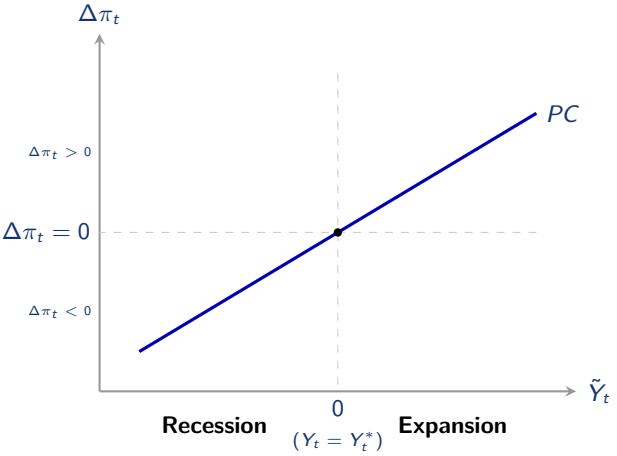
$$\pi_t = \pi_{t-1} + \theta \tilde{Y}_t$$

- In change form:

$$\Delta\pi_t = \theta \tilde{Y}_t$$

- This gives us the Phillips curve

The Phillips Curve



Price Shocks and the Phillips Curve

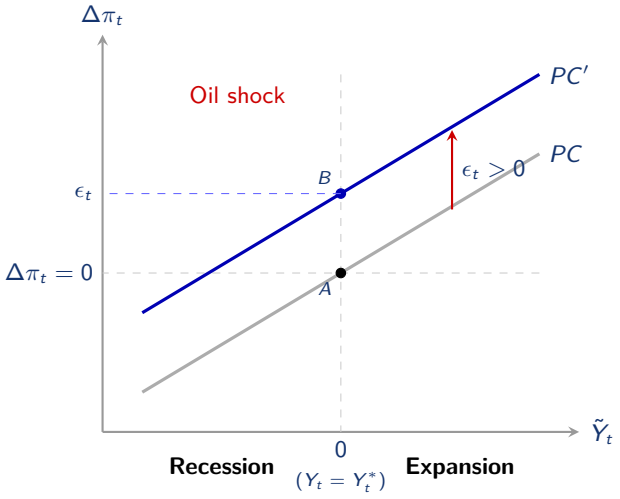
- The Phillips curve can also include shocks that affect inflation directly:

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

- The term ϵ_t is a **price shock**: a change in inflation that is not caused by the output gap.
- Example: an oil shock raises production costs for many firms.
  - Firms raise prices even if output is at potential.
  - Inflation rises for a given level of $\tilde{Y}_t$.
- A positive price shock, $\epsilon_t > 0$, shifts the Phillips curve upward.

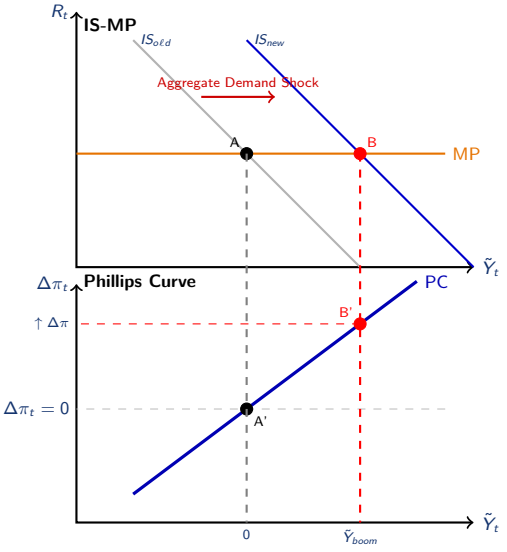
Price Shocks and the Phillips Curve

Oil Shock



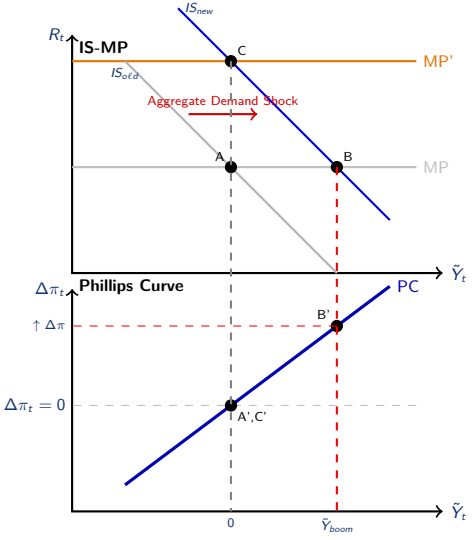
Aggregate Demand Shock

From Boom to Price Pressures

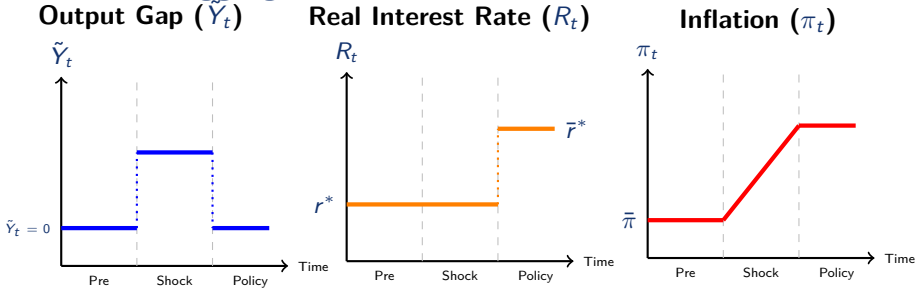


Optimism Shock

Stabilizing Inflation



Dynamics from Aggregate Demand Shock



- **Shock:** The output gap ($\tilde{Y}_t$) jumps with the surge of investment/consumption.
- **Inflation:** Starts rising due to the Phillips Curve ($\Delta\pi > 0$).
- **Policy:** Central bank raises R_t to $\bar{r}^*$. The output gap returns to 0 and inflation stabilizes at its new, higher level.
- How could you bring down inflation? Create a recession by raising interest rates

Monetary Policy Rules

- The short-run model is built from three equations:
  - **IS curve**: $\tilde{Y}_t = a - b(R_t - r^*)$
  - **MP curve**: the central bank chooses the real interest rate R_t
  - **Phillips curve**: $\Delta\pi_t = \theta\tilde{Y}_t + o_t$
- There is a fundamental trade-off:
  - Higher short-run output $\Rightarrow$ higher inflation
- By setting R_t, the central bank chooses how to manage this trade-off.

Monetary Policy Rules and Aggregate Demand

- A **monetary policy rule** specifies how the central bank adjusts interest rates in response to economic conditions.
- A simple rule:

$$R_t - r^* = \bar{m}(\pi_t - \bar{\pi})$$

  - Raise interest rates when inflation exceeds the target $\bar{\pi}$
  - Lower interest rates when inflation is below target
  - $\bar{m}$ controls how aggressively monetary policy responds to inflation

- Many advanced economies target $\bar{\pi} = 2\%$ (U.S., euro area, U.K., Japan).