

The Natural Rate of Interest

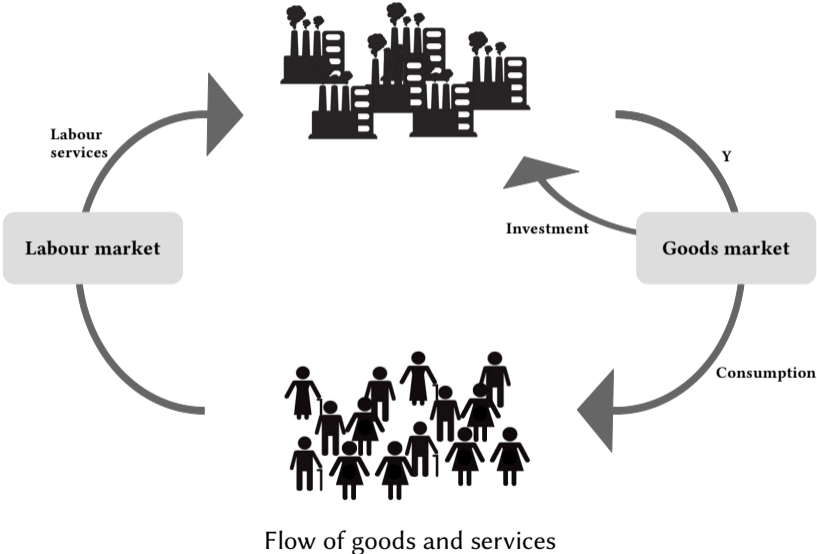
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Slides adapted from Jonna Olsson

Fall 2024

The model we have formulated



Aggregate supply (AS)

- ▶ In Chapter 2, we analyzed how production is related to the input of production factors according to the production function:

$$Y = F(K, EN)$$

- ▶ We argued that, in the long run, employment should be at the *natural level*, so the long-run equilibrium (natural) level of production is determined by

$$Y^n = F(K, E(1 - u^n)L)$$

We're taking u^n as a given (for now)

- ▶ This production is the **aggregate supply** of goods in the economy.

Aggregate demand (AD)

- ▶ However, this is a market, and we need to know **what is the demand for goods** as well
- ▶ Firms do not produce if there is no demand for their products
- ▶ In Chapters 3 and 4, we learned that the goods produced by the firms are demanded for both investment and consumption.
- ▶ At any point in time, actual production is determined by aggregate demand, which consists of the sum of consumption and investment:

$$Y = C(Y, Y^e, r, A) + I(r, Y^e, K)$$

- ▶ It is natural to ask ourselves: **what is the price that clears this market?**

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AS-AD model

- ▶ We combine both of these elements to make the aggregate supply and aggregate demand model, also known as the AS-AD model.
- ▶ We can graph this the same way as we do with microeconomic supply and demand graphs.

In this case, we put Y , the quantity of output both supplied and demanded on the x -axis.

- ▶ But what goes on the y -axis? What is the price in our economy?
- ▶ Since we know aggregate demand is:

$$Y = C(Y, Y^e, r, A) + I(r, Y^e, K)$$

we can ask ourselves: what prices show up here?

- ▶ Answer: just the **real interest rate**

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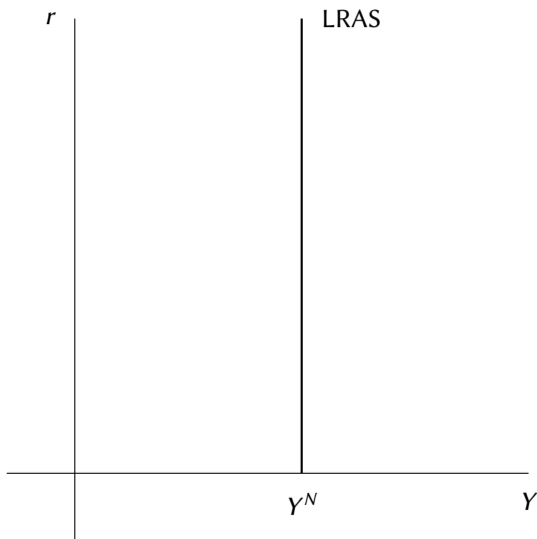
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Aggregate Supply (Long Run)

- ▶ **Claim:** Long-Run Aggregate Supply curve vertical
- ▶ In the long run, the level of output is determined by the amounts of capital and labor and by the available technology.
- ▶ It does **not** depend on the interest rate level.
- ▶ Therefore, the long-run aggregate supply curve (LRAS), is vertical.

$$Y^n = F(K, E(1 - u^n)L)$$

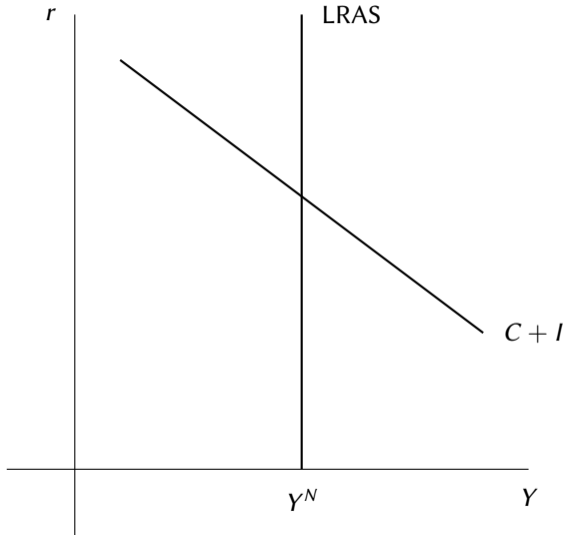


Aggregate Demand

- ▶ **Claim:** Aggregate demand (AD) is downward sloping

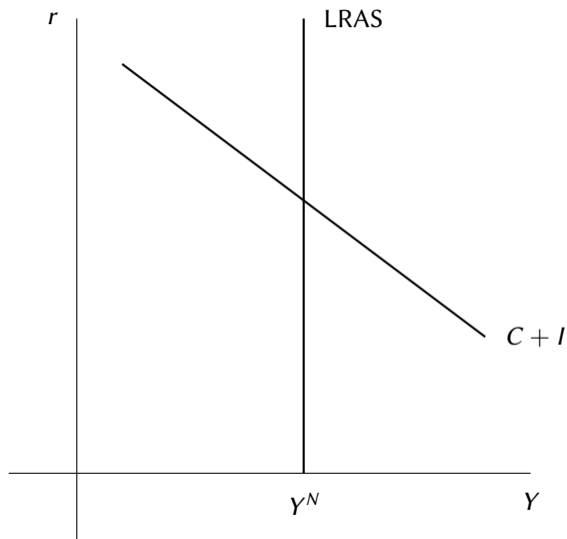
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- ▶ In our analysis, both consumption and investment are decreasing functions of r
- ▶ Higher interest rates make it
 - ▶ more costly to invest
 - ▶ not as desirable to consume
- ▶ Higher interest rates lead to lower investment and consumption



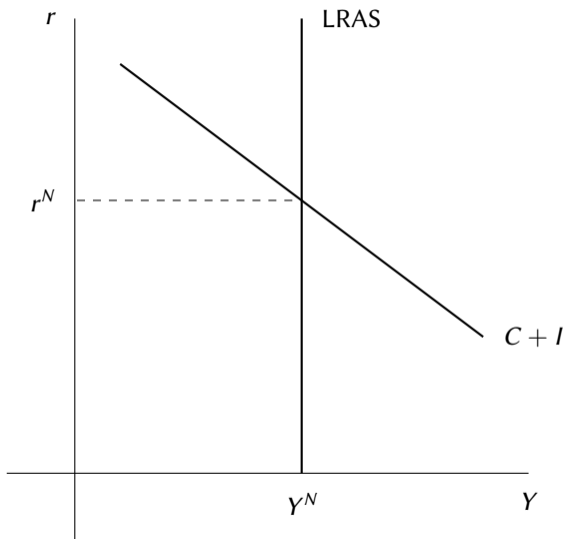
The natural rate of interest

- ▶ There is a price that causes aggregate supply to equal aggregate demand
- ▶ This is just the r that makes demand be equal to the natural level of output
- ▶ Call this interest rate r^N
- ▶ This is the **natural rate of interest**
- ▶ We can see it on the graph by looking at the intersection of the AS and AD curves



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Shift in curves

What shifts the curves?

▶ LRAS

- ▶ Remember that the LRAS curve is only determined by the level of capital, labor, technology, and the natural rate of unemployment in the economy.
- ▶ Therefore, only changes in these four variables can shift the LRAS curve.

▶ AD

- ▶ Since AD is only made up of consumption and investment only increases in these two can shift AD to the right.
- ▶ In larger models it is also possible to add in things like government spending, taxes, and net exports.

Temporary fall in production

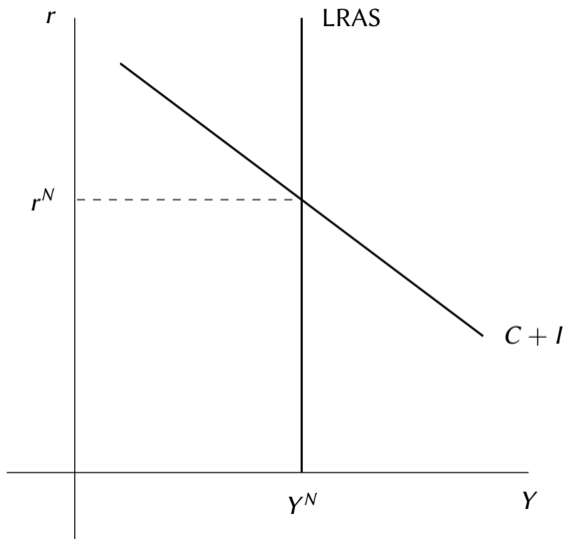
- ▶ What happens if there is a temporary reduction in production (e.g. a bad harvest)
- ▶ We can think about this as a temporary reduction in E that lowers the *natural level of output*
- ▶ This means the LRAS shifts left – economy can produce fewer units of output

$$Y^n = F(K, E(1 - u^n)L)$$

- ▶ However, since income has fallen, consumption will also fall (not as much as income) so AD shifts left

$$Y = C(Y, Y^e, r, A) + I(r, Y^e, K)$$

- ▶ Overall the natural rate of interest increases



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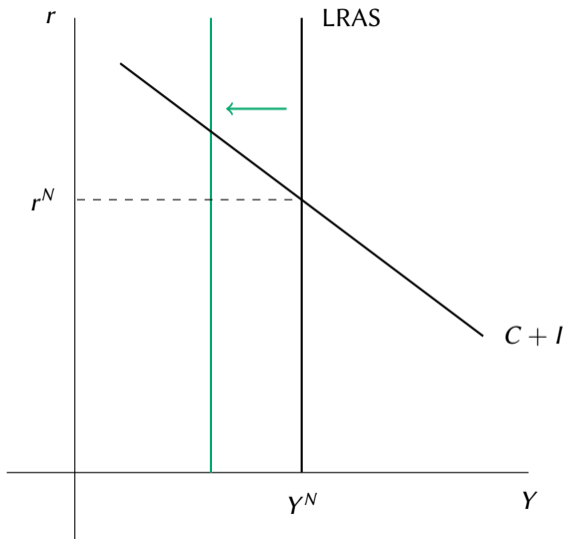
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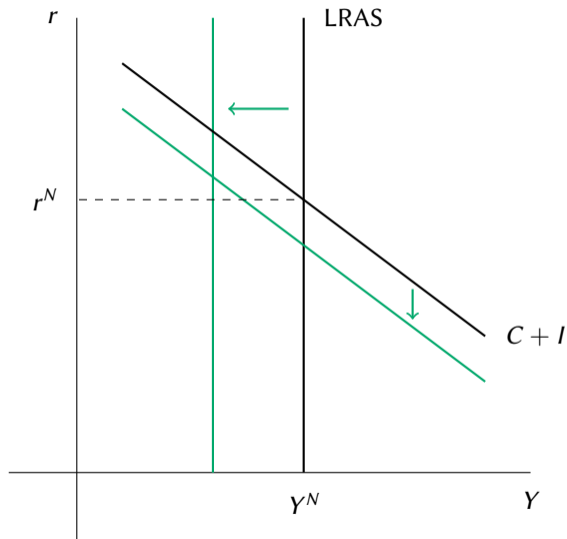
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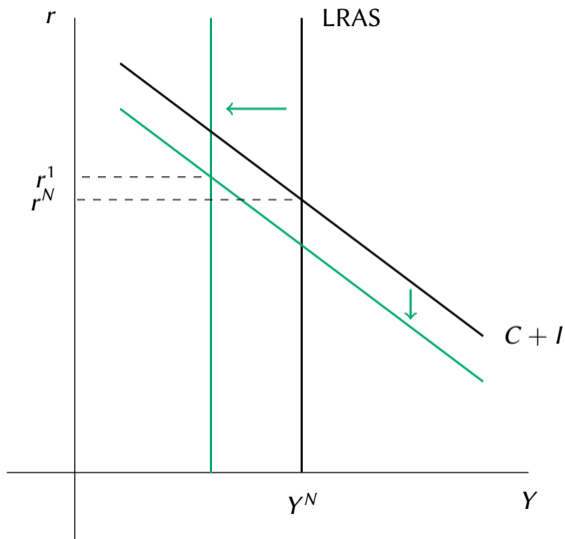
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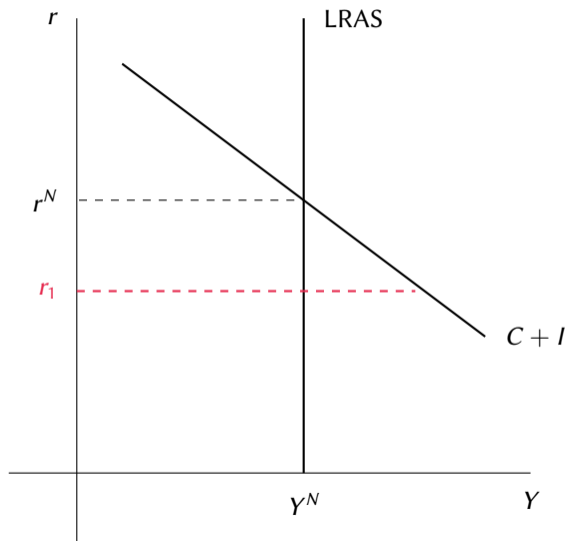
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Analysing short-run dynamics in the AS-AD framework

- ▶ What happens if r is below r^n ?
- ▶ If this happens, then production will be *above the natural level* and, therefore, so will employment.
- ▶ If employment was already at its natural rate then wages must rise to tempt more people in to the labor force.
- ▶ If wages rise then inflation will rise.
- ▶ Eventually, the central bank will raise the nominal interest rate, which, if goods prices are slow to adjust, will raise the real interest rate, reduce demand and bring the economy back to long-run equilibrium

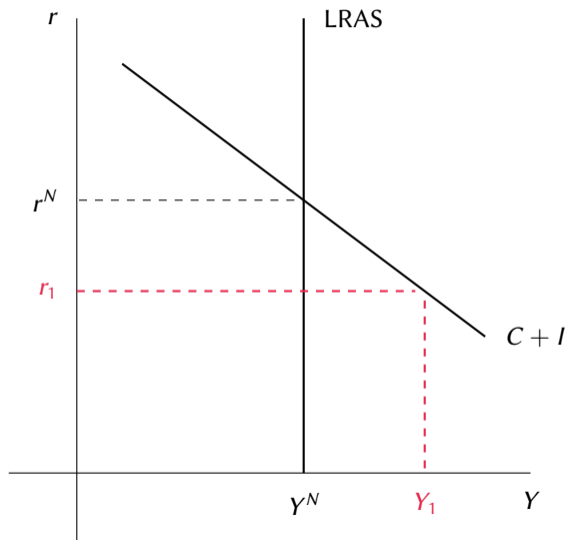
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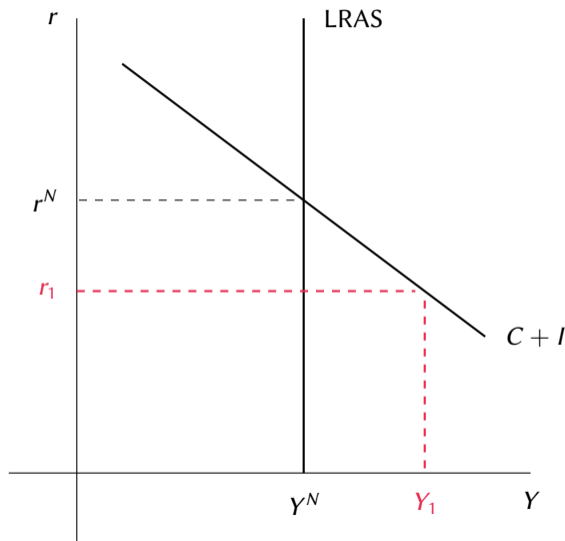
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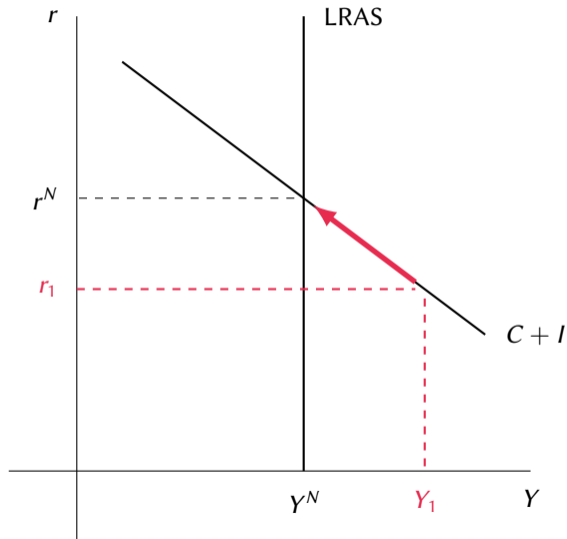
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Who sets the real interest rate?

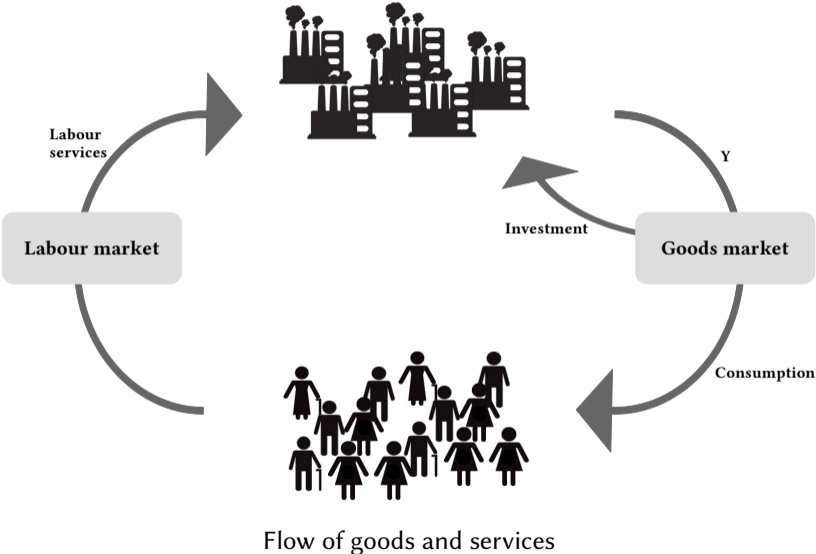
- ▶ In the long run, we expect production to be at the natural level
- ▶ Thus, the real interest rate must be equal to its natural level
- ▶ But who fixes this?

One way to think about it (short run):

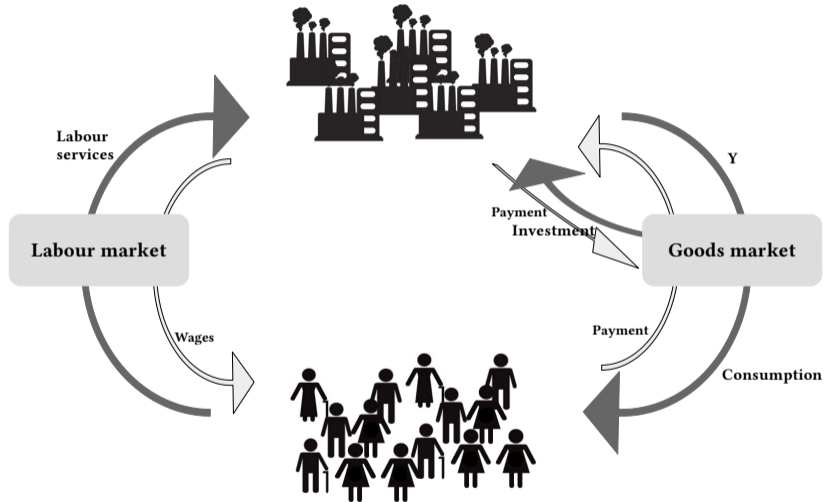
- ▶ The Central Bank reacts to deviations from the natural level of output
- ▶ Adjusts the nominal interest rate to get back to the natural level

This is what we saw in the previous two slides!

The model we have formulated

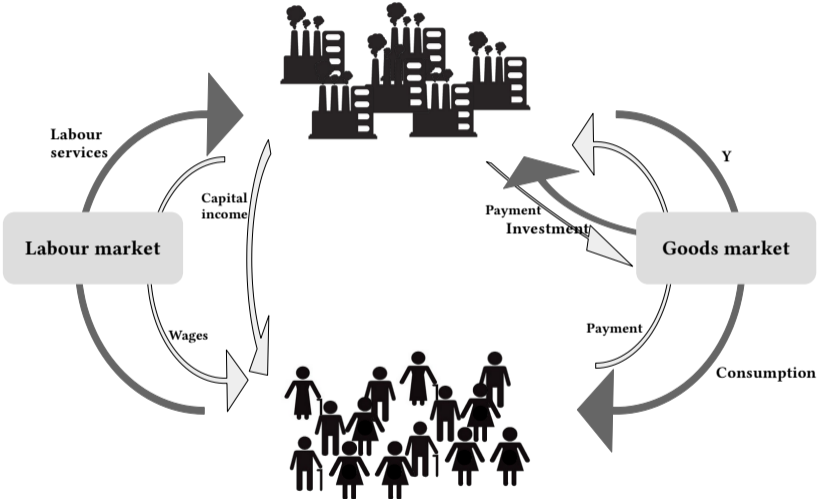


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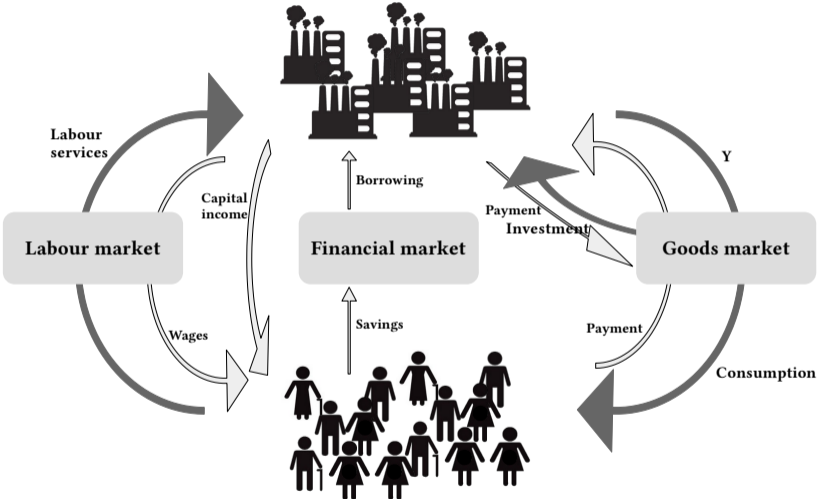
Flow of goods and services and payments (step 1)

The model we have formulated



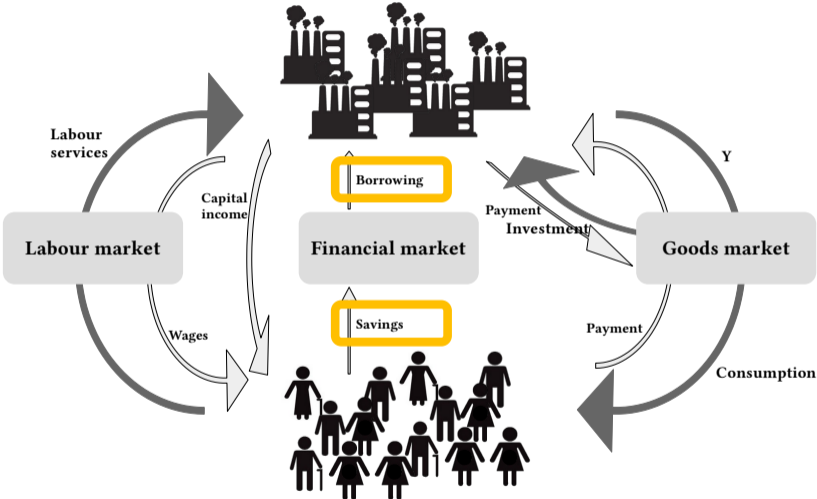
Flow of goods and services and payments (step 2)

The model we have formulated



Flow of goods and services and payments (step 3)

The model we have formulated



Flow of goods and services and payments (step 3)

Investment and savings

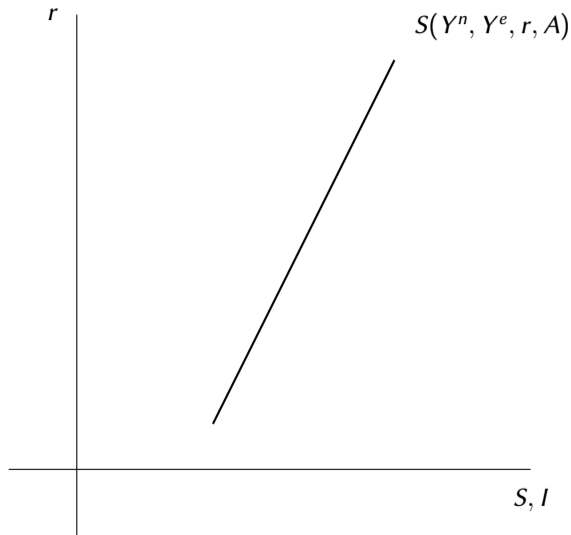
- ▶ An alternative way to look at the long-run equilibrium is to define the savings function:

$$S(Y, Y^e, r, A) = Y - C(Y, Y^e, r, A)$$

- ▶ We can then write the long-run equilibrium condition

$$S(Y^n, Y^e, r, A) = I(r, Y^e, K)$$

- ▶ Thus, another way to define the natural rate of interest is as **the real interest rate that makes desired savings equal to desired investment** when production is at its natural level.



Investment and savings

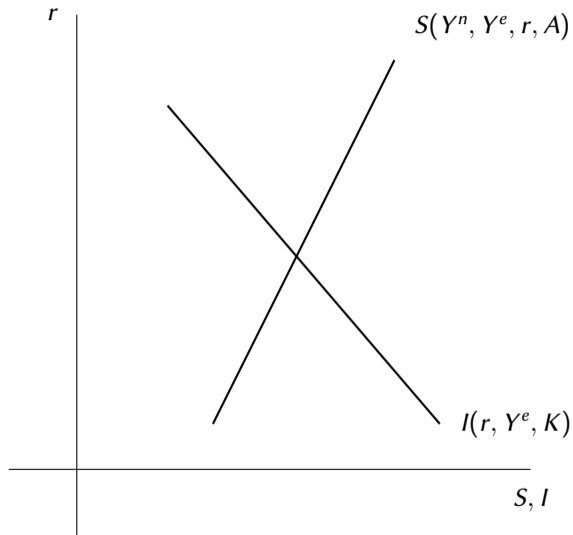
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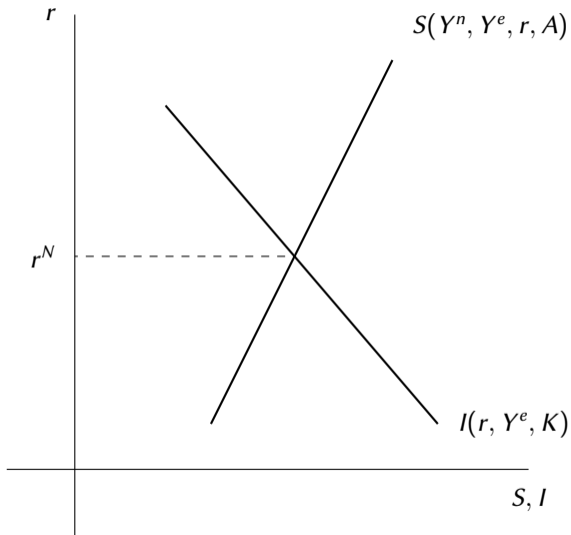
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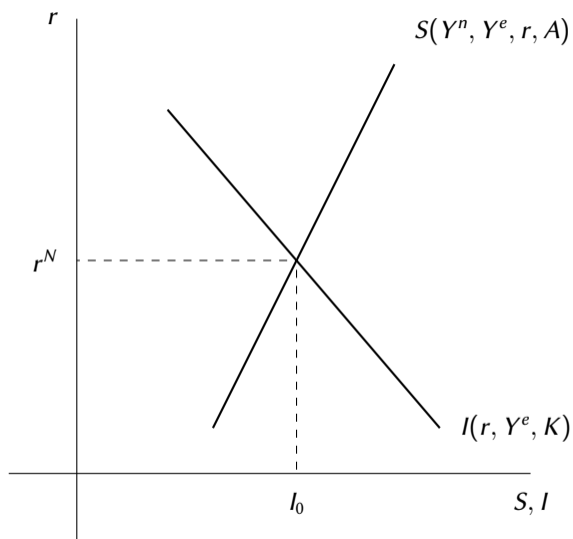
SI framework: shift in curves

“A pension reform leads to increased savings as people realise that their pensions will be lower”

- ▶ Think about it as $Y^e \downarrow$

$$S(Y, Y^e, r, A) = Y - C(Y, Y^e, r, A)$$

- ▶ More savings shift the savings curve to the right
- ▶ Excess supply of savings put downward pressure on the interest rate
Since not enough firms want to invest with the current interest rate
- ▶ In new equilibrium, the interest rate is lower
- ▶ ...which increases investment as well



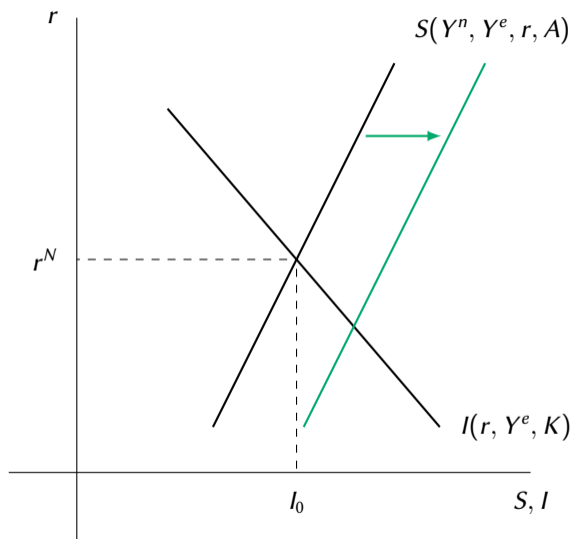
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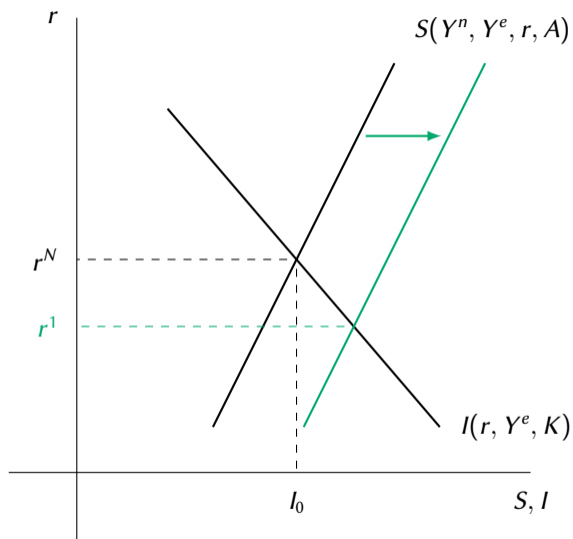
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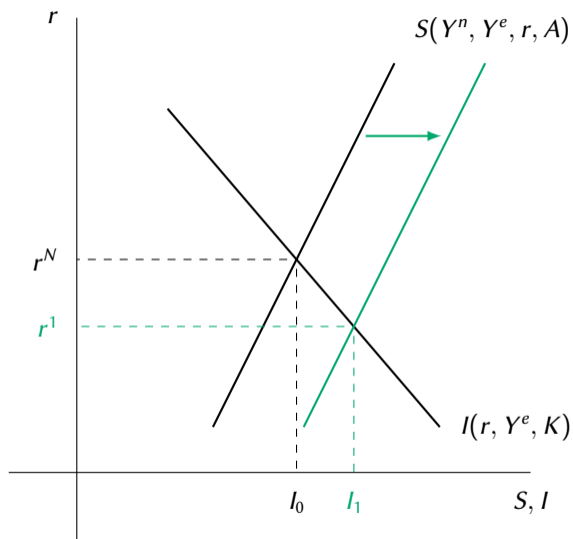
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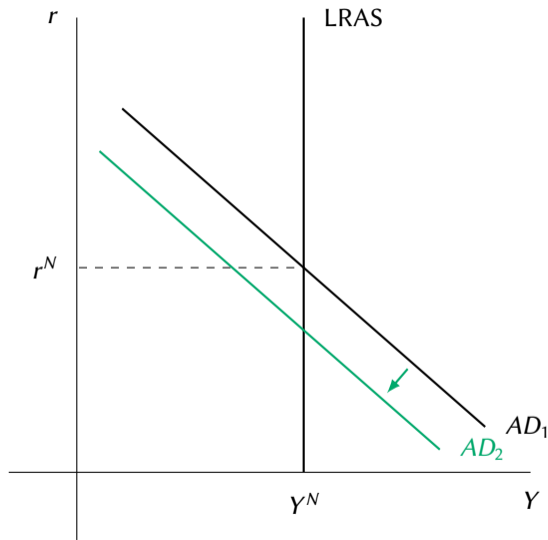
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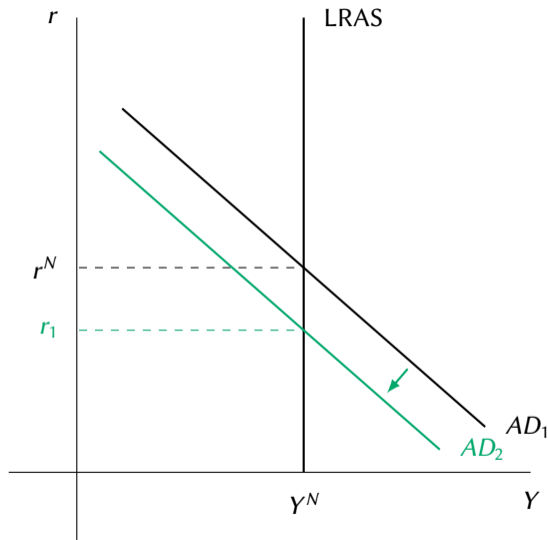
AS/AD framework: exactly the same example

- ▶ For a given real interest rate consumption is lower
- ▶ Thus, the AD curve shifts in
- ▶ To get aggregate supply equal to aggregate demand, the interest rate needs to fall
- ▶ A fall in interest rate increases both consumption and investment
- ▶ In the very long run, output will increase
- ▶ Why? Extra investment will lead to higher capital stock (and therefore higher output)
- ▶ This is the topic we'll be covering next (Chapter 5)!



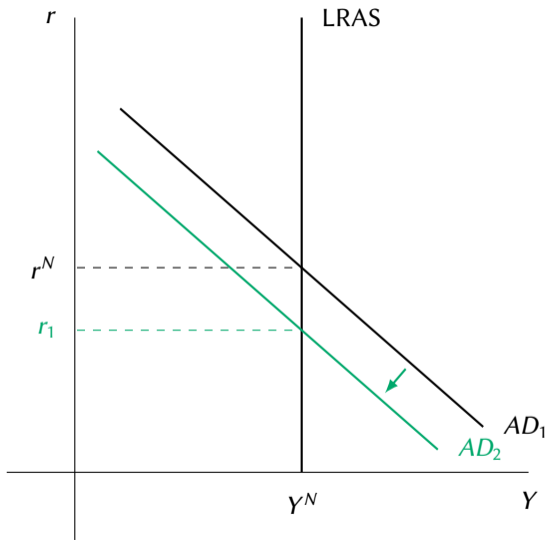
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The Fisher equation

A **definition** (as in Chapter 3):

$$r = i - \pi$$

But we can also think of it as a **causal statement**:

$$i = r + \pi$$

- ▶ A long-run interpretation
- ▶ We saw that the real interest rate is determined by willingness to save and invest, two decisions that depend on *real* factors
- ▶ If inflation increases, nominal interest rate must increase to “compensate”

i_t and π_{t+1} (from Lecture 3)

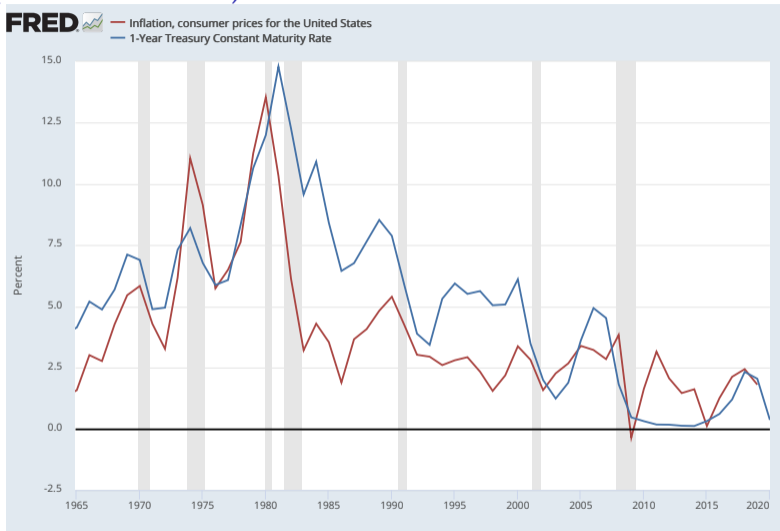


Figure: Source: <https://fred.stlouisfed.org/>

Why does the real interest rate fluctuate?

1. The natural rate of interest is not constant!
 - ▶ Real shocks (affecting the willingness to save and invest) have a direct effect
2. The decision to save and invest is based on *expected* inflation
 - ▶ What if inflation raises more than anticipated? How will that affect the *realized* real interest rate?
3. The real rate can deviate from its natural level in the short run
 - ▶ Monetary policy and credit market regulations (will be further discussed in Chapter 8-10)

Where to go from here?

- ▶ **Growth:** Allow capital stock, employment and technology to change in the current model. Also consider the role of institutions. (Chapter 5)
- ▶ **Labour market:** Understand what determines u^n in the medium run and how $u \lesseqgtr u^n$ affects wage inflation in the short-run. (Chapter 6)
- ▶ **Money and inflation:** Understand the (long-run) neutrality of money under flexible prices and the costs (and benefits) of inflation. (Chapter 7)
- ▶ **Economic fluctuations:** Understand how: (Chapters 8 and 9)
 1. output is determined if prices adjust slowly (short-run)
 2. why inflation responds slowly, relation to the labour market
 3. the role of monetary policy in such an environment