Monetary Policy

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

Lecture 8: Monetary Policy Transmission, Zero Lower Bound

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Outline

Part 1: Basic Macroeconomic Concepts

Part 2: Conventional Monetary Policy

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

- Lecture 8: Monetary Policy Transmission, Zero Lower Bound
- Lecture 9: IS-MP-PC Model With ZLB, Unconventional Monetary Policy
- Lecture 10: Unconventional Policy Effects, Zero Interest Equilibrium

Part 4: Monetary and Fiscal Interactions

Part 5: Financial Stability (if time permits)

Mock Exam

Learning Objective of Today‘s Lecture

1. Understand basic term structure theory
2. Get to know the most important transmission channels of monetary policy
3. Get to know empirical evidence on monetary policy transmission
4. Introduce the ZLB in the IS-PC model
5. Understand deflationary spirals

Literature

Required reading

- Karl Whelan (2020). Lecture Notes on Macroeconomics, Chapter 4 “The Zero Lower Bound and the Liquidity Trap“ pp. 87-108. https://www.karlwhelan.com/Macro2/Whelan-Lecture-Notes.pdf

Optional readings

- Frederic Mishkin (1996). “The Channels of Monetary Transmission: Lessons for Monetary Policy,” NBER Working Papers 5464.
- Ben Bernanke and Mark Gertler (1995). “Inside the Black Box: The Credit Channel of Monetary Policy Transmission,” Journal of Economic Perspectives 9(4): 27–48.

8.1 Basic Term Structure Theory

The Term Structure of Interest Rates

So far, we have abstracted from the fact that many different interest rates exists, which differ depending on factors such as maturity, risk and liquidity.

Focusing only on the maturity of a bond, there is a whole range of possibilities, and hence interest rates (or more precisely yields), ranging from overnight to many years (there are even perpetual bonds).

The **term structure of interest rates** shows the yield for a particular type of bonds for different maturities.

Example 1: Yield curve for US Treasury bonds

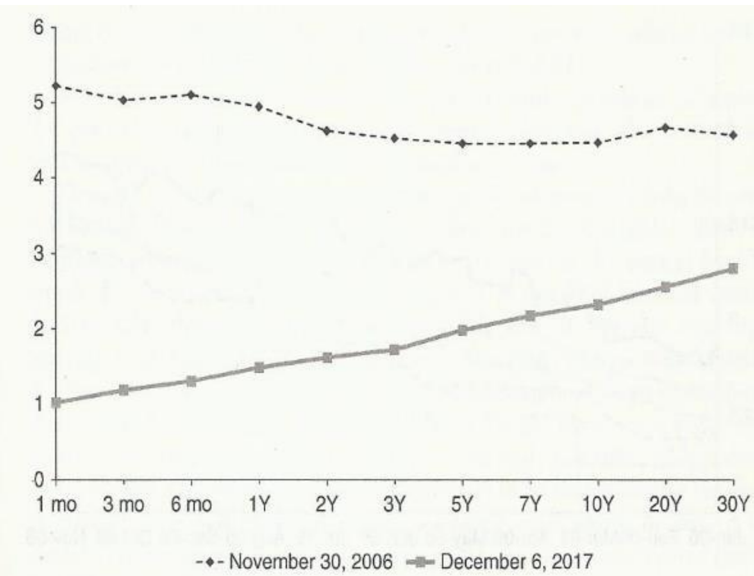
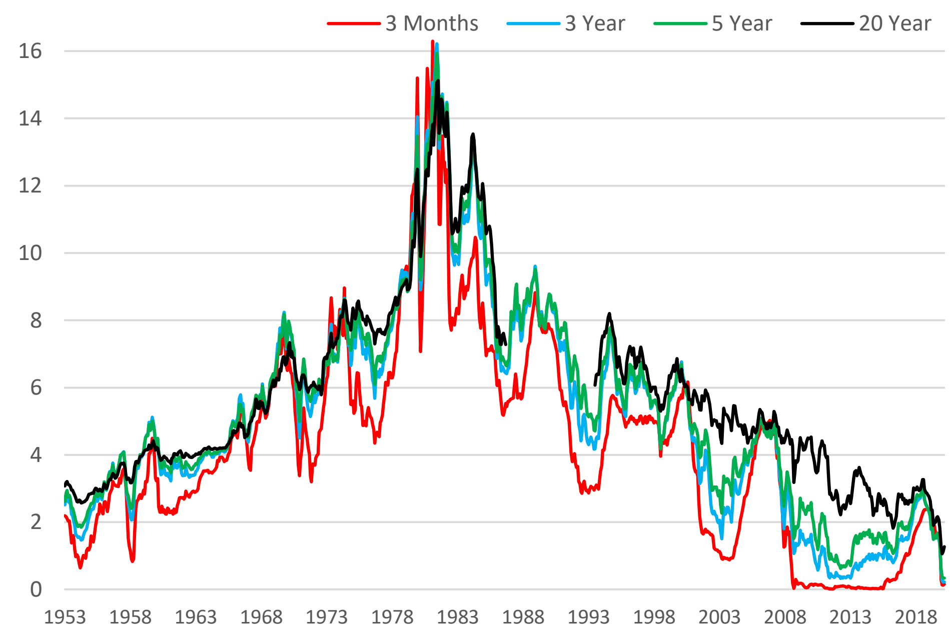


Figure 5.2 Yield curve for US Treasury bonds, in percent per year.
US Department of Treasury. Source: Benassy-Quéré et al. (2019)

Example 2: Movements of interest rates over time (US government bonds)



Source: St. Louis FRED, own computations

Characteristics of the Term Structure

Three main characteristics of the term structure:

1. Yields of bonds of different maturities move overall together over time
2. When short term yields are low, the yield curve is more likely to have an upward slope; when short-term yields are high, yield curves are more likely so slope downward (inverted yield curve)
3. Yields curves slope upwards most of the time

Central banks conduct conventional monetary policy by manipulating the short-term rates, but it is mainly the long-term rates that affect consumption and investment decisions of economic agents.

Thus, analyzing interest rate movements along the yield curve provides valuable information regarding monetary policy impact.

Unconventional monetary policy aims at affecting longer-term rates directly, so that we need to some term structure theory before studying Quantitative Easing and Forward Guidance.

There are different theories that aim to explain the observed characteristics and give a basis on how long-term yields are composed.

Expectations Theory

- It assumes that bonds of varying maturities are perfect substitutes (ex ante or expected) for one another.
- This implies the following arbitrage condition: The interest rate on a long-term bond equals the average of the expected short-term interest rates over the life of the long-term bond.
- The interest rate for a N-year maturity, i_t^N, can thus be expressed as a function of the N expected 1-year maturity rates i_{t+i}.

$$i_t^N = \frac{i_t + E_t i_{t+1} + \cdots + E_t i_{t+N-1}}{N}$$

- Intuition: Rather than holding a 2-year bond until maturity an investor can hold a 1-year bond until maturity and then re-invest the money into another 1-year bond. The return of both strategies should be the same in expectations. Otherwise, there are arbitrage opportunities.
- The theory can explain why short- and long-term interest rates often move together over time (characteristic 1): Long rates depend on current and expected future short rates, so if short rates are trending in one direction, we would expect long rates to also go in that direction.
- It can also explain why the yield curve is likely to be upward sloping when short-term interest rates are low and downward sloping when they are high (characteristic 2). When short term interest rates are below (above) their long-term average, one can expect them to increase (decrease) in the future, so that the long-term interest rates are higher (lower) than the short-term interest rates.
- The theory cannot explain why the yield curve is upward sloping most of the time (characteristic 3). This is because the theory abstracts from all kinds of risks including those that give rise to a term premium.

Segmented Markets Theory

- Assumption: Bonds with different maturities are not substitutes (opposite of expectation theory)
- Different investors might have preferences for different maturities, so that markets for bonds of different maturities are segmented and no arbitrage takes place.
- Intuition: A pension fund has a very long-term investment horizon, while a money market funds needs to be highly liquid and invests in short-term bonds.
- The demand and supply of bonds in the different market segments determines the yield.
- Risk averse investors might prefer short-term bonds, so that they require a term premium to hold long-term bonds. This can explain why most of the time the yield curve is upward sloping (characteristic 3).
- The segmented markets theory cannot explain characteristics 1 and 2.

Liquidity Premium Theory

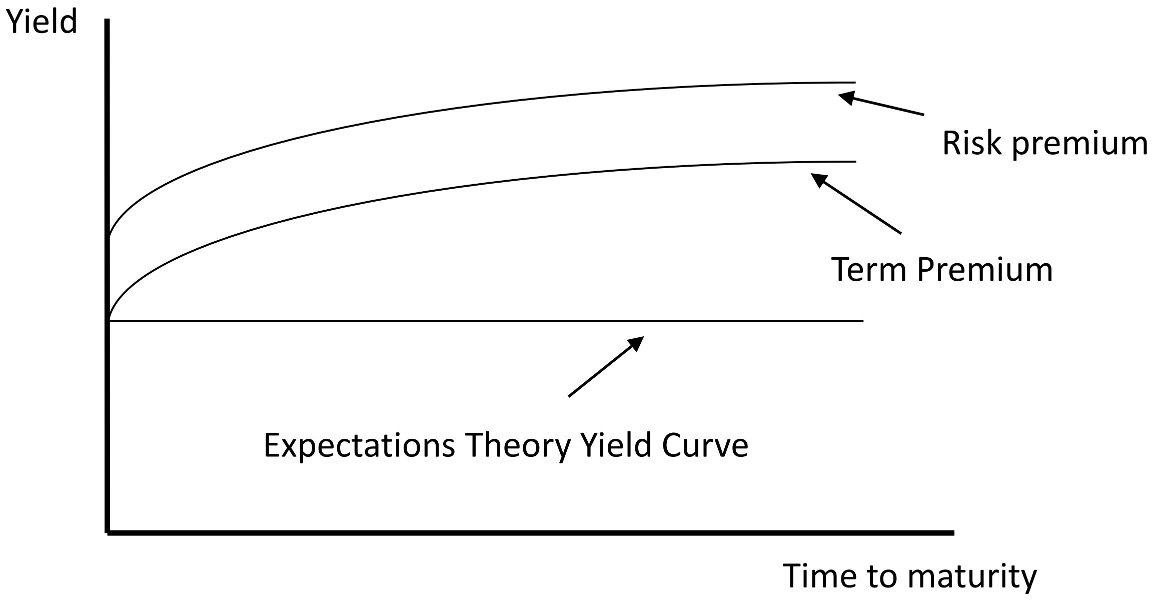
- Combines the two previous theories, so that all three characteristics of the term structure can be explained.
- Assumption: Bonds with different maturities are imperfect substitutes.
- One the one hand, there is a link between short- and long-term bonds via the expectation theory, but on the other hand, investors might require a liquidity or term premium l_t^N for holding long-term bonds due to the larger interest rate risk (if you want to sell before maturity, your return depends on the current price (or yield) and not only on the coupon).

$$i_t^N = \frac{i_t + E_t i_{t+1} + \cdots + E_t i_{t+N-1}}{N} + l_t^N$$

- The liquidity premium increases with maturity N.
- Closely related is the preferred habitat theory. Investors prefer a particular market segment (risk averse investors prefer bonds with short maturities) but are willing to buy from a different market segment if they get a higher return.
- For corporate bonds there is an additional risk premium that depends on the probability of default.

The Yield Curve

- Expectation theory: yields for the long term equal the average expected short term yield. Thus, a change in the policy rate (short-term) also affects long-term rates, important for investment and savings decisions.
- Liquidity premium theory: investors require a liquidity or term premium for holding long-term bonds due to the larger interest rate risk
- In case of risky bonds there is an additional risk premium on top. Its size depends on the default risk, which is measured by rating agencies



8.2 Monetary Policy Transmission

Transmission of a Monetary Policy Shock: IS-MP-PC Model

- In the IS-MP-PC model, monetary policy is first transmitted via the IS curve to the output gap and then via the Phillips curve to inflation.
- The transmission can be most clearly traced out if we add a monetary policy shock to the MP curve:

$$i_t = r^* + \pi^* + \beta_\pi(\pi_t - \pi^*) + \varepsilon_t^i$$

- Recall the IS curve

$$y_t = y_t^* - \alpha(i_t - \pi_t - r^*) + \varepsilon_t^y$$

- Combining the two yields the IS-MP curve:

$$y_t = y_t^* - \alpha(\beta_\pi - 1)(\pi_t - \pi^*) + \varepsilon_t^y - \alpha\varepsilon_t^i$$

- Recall the Phillips curve

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

- Inserting the IS-MP curve into the PC (after some re-arranging, compare to lecture 6) yields the **solution for inflation**:

$$\pi_t = \theta\pi_t^e + (1-\theta)\pi^* + \theta(\gamma\varepsilon_t^y + \varepsilon_t^\pi - \alpha\gamma\varepsilon_t^i), \qquad \theta = \frac{1}{1+\alpha\gamma(\beta_\pi - 1)}$$

- The **solution for output** can be found by substituting the solution for inflation into the IS-MP curve:

$$y_t = y_t^* - \alpha(\beta_\pi - 1)\big(\theta(\pi_t^e - \pi^* + \gamma\varepsilon_t^y + \varepsilon_t^\pi - \alpha\gamma\varepsilon_t^i)\,\big) + \varepsilon_t^y - \alpha\varepsilon_t^i$$

$$\Leftrightarrow y_t = y_t^* - \theta\alpha(\beta_\pi - 1)(\pi_t^e - \pi^* + \varepsilon_t^\pi) + \big(1 - \theta\alpha\gamma(\beta_\pi - 1)\big)\varepsilon_t^y + \alpha(\theta\alpha\gamma(\beta_\pi - 1) - 1)\varepsilon_t^i$$

Effects of a Monetary Policy Shock: IS-MP-PC Model

Direct effect of a monetary policy shock on inflation:

$$-\alpha\gamma\theta \qquad \text{with} \qquad \theta = \frac{1}{1+\alpha\gamma(\beta_\pi - 1)}$$

Direct effect of a monetary policy shock on output:

$$\alpha(\theta\alpha\gamma(\beta_\pi - 1) - 1)$$

- For reasonable calibrations, ε_t^i has a negative effect on inflation and on output.
- For $0 < \theta < 1$ the effect on inflation will be temporary (short-lived under rational expectations, and more persistent under adaptive expectations).
- A temporary effect on inflation implies a permanent effect on the price level. Once the effect of inflation has faded out, the price level will be stable, but on a different level than prior to the occurrence of the shock.
- There might be further effects via changes in π_t^e. To analyze these one would need to model expectation formation.
- The IS-MP-PC model abstracts from different rates but provides a good illustration of the effect of a change in the policy rate on output and inflation.
- The following slides explain different mechanisms through which monetary policy affects those macroeconomic variables.

The Interest Rate Channel

So far, we have looked at monetary policy transmission via the IS-curve. This is the traditional Keynesian interest rate channel:

- A change in the nominal interest rate affects the real interest rate if there are nominal rigidities.
- The real interest rate affects investment. This is the transmission channel emphasized by Keynes and in the IS-LM model. One can view consumer spending on housing and durable expenditures also as investment decisions.
- The real interest rate also affects the consumption-savings decision. This effect is the main transmission channel in the basic New Keynesian model and is known as the intertemporal substitution in consumption effect.
- Overall, the effects on investment and/or consumption affect demand and thereby the output gap. This is captured in the IS curve. In turn, inflation is affected via the Phillips curve.
- The effectiveness of the interest rate channel varies across countries. For example, in Germany and France households usually borrow at a fixed rate, so that the interest rate channel affects them only once they renegotiate with their bank, while in the U.K or Spain this channel has an immediate impact, given that households generally borrow at a variable rate.
- A change in the interest rate also implies a change in the exchange rate, which affects net exports. This is the exchange rate channel.

The Asset Price and the Risk Channel

The Asset Price Channel

- Relies on the negative relationship between asset prices and interest rates: a decrease in the interest rate generally raises the value of financial assets.
- Example stocks: if investors are risk-neutral the fundamental value is equal to the net present value of expected future dividends. A higher interest rate discounts more heavily future cash flows and therefore immediately decreases the value of the stock.
- A change in the value of financial assets affects household wealth and in turn consumption decisions.
- A change in the value of stocks increases investment. Firms can buy a lot of new investment goods with only a small issue of stocks (Tobin's q theory)

The Risk Channel

- Closely related to the asset price channel
- A lower interest rate leads investors and banks to take more risk, i.e. softening lending standards
- Reasons are the increased value of collateral and "search for yield".
- Thereby, monetary policy is one of the drivers of financial cycles.

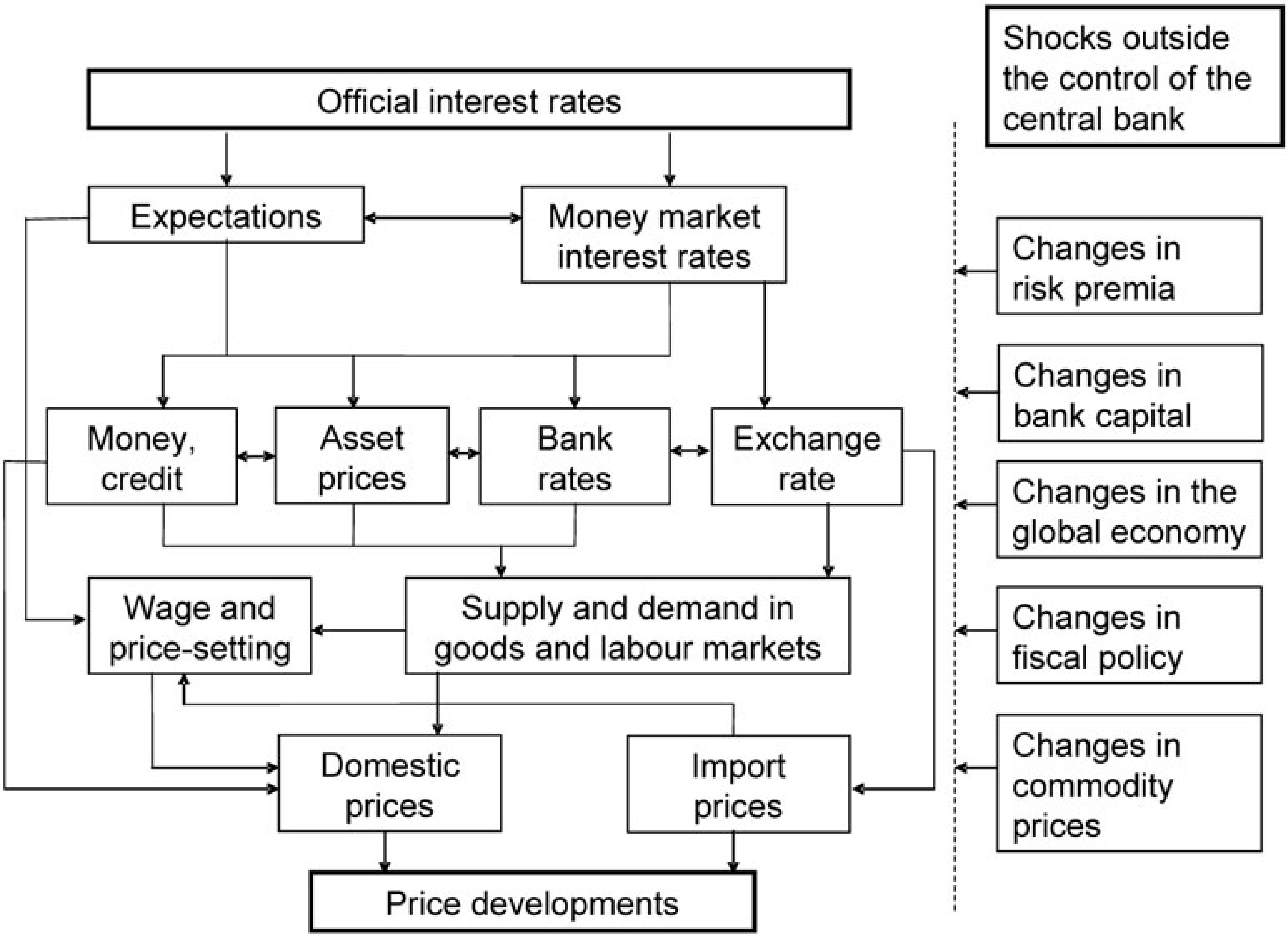
The Credit Channel

The credit channel works via the supply (not demand) of credit and is based on asymmetric information between borrowers and lenders. In response to an improvement in their refinancing conditions, banks tend to increase their supply of credit, in addition to reducing their lending rates.

- Asymmetric information between borrowers and lenders leads to a risk premium charged as a compensation for default risk if assessing the quality of all investments projects of borrowers is difficult.
- Such a risk premium penalizes good investment projects whose probability of failure is low. Investors who want to undertake highly risky investment projects with a high probability of default may not be discouraged and accept paying the premium.
- This *adverse selection* problem increases if the value of collateral decreases. Hence, an increase in the interest rate is not only followed by higher credit rates, but also by a reduction in the supply of credit and an increase in the risk premium. Overall, financing costs of investment increase, decreasing investment.
- The interest rate effect of monetary policy is amplified, so that this is called the financial accelerator effect.

While these channels - except for interest rate channel - did not show up in the derivation of the IS curve, we can think about them as affecting the strength of the link between the interest rate and the output gap in the IS curve.

Transmission of Monetary Policy



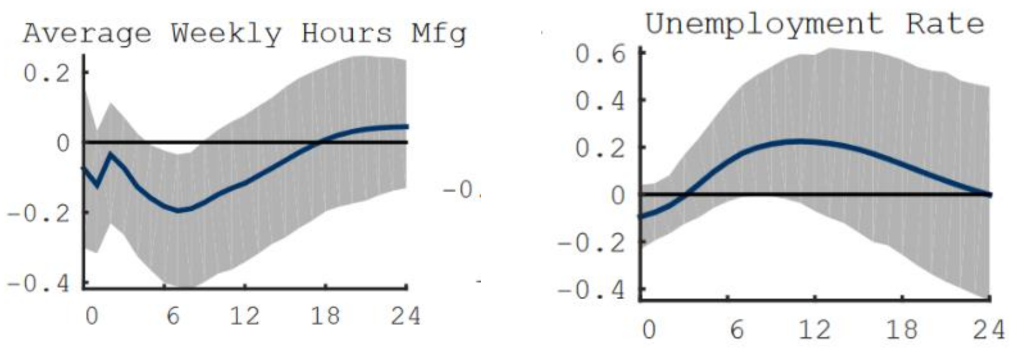
Source: ECB

Transmission of Monetary Policy Empirically

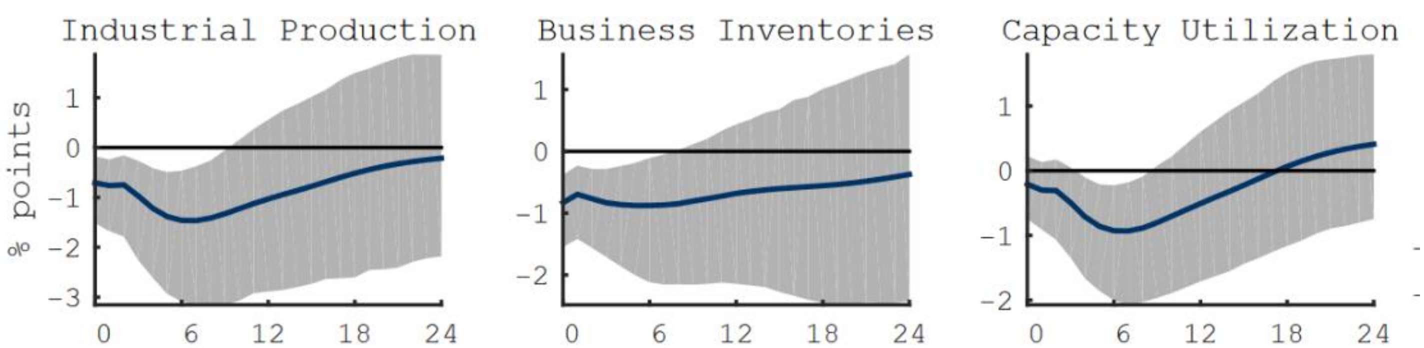
Monetary policy transmission can be estimated using Vector Autoregressions (VAR). These are straightforward to estimate (use OLS). The difficulty lies in identifying exogenous monetary policy shocks.

- It can easily happen that one studies impulse response to shocks that are contaminated by other influence factors.
- Part of the literature tries to filter out exogenous shocks based on some identifying assumptions in the VAR. Others construct exogenous shocks prior to estimating the VAR and include them as an additional variable in the VAR.
- Recent example based on Miranda-Aggripino and Ricco (2020, AEJ:Macro). US data 1979M01-2014M12
  - Measure market-based monetary surprise as the difference of federal funds rate future and the actual federal funds rate realization.
  - Then they include the resulting measure in a VAR and compute impulse response functions to the shock.
  - They find that a monetary tightening is unequivocally contractionary, with deterioration of domestic demand, labor and credit market conditions, as well as of asset prices and agents' expectations.
  - The following figures show impulse response functions to a 1 percentage point increase in the short-term interest rate.

Monetary Policy Transmission: Real Activity and Labor Market

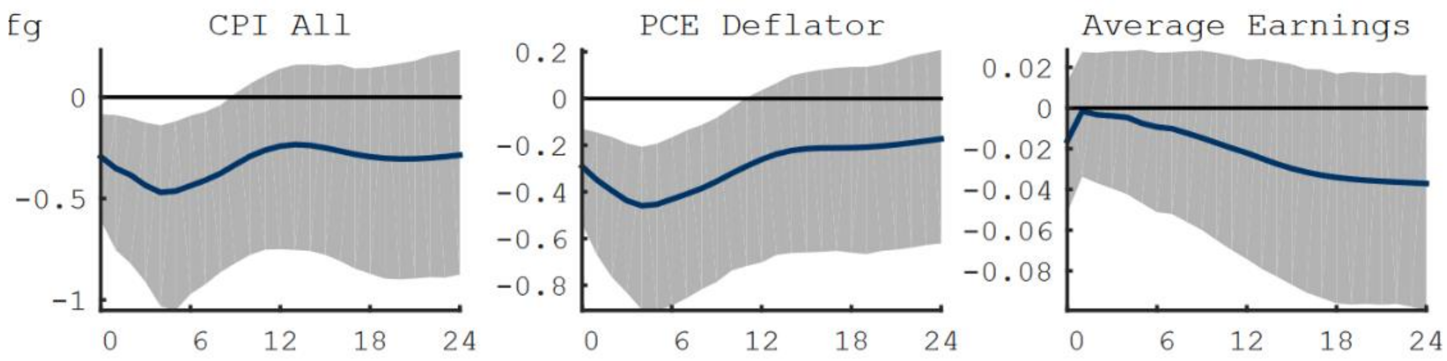


- Labor market reacts with a delay. Hours fall and the unemployment rate increases.
- Suggestive of the presence of frictions in the labor market, such as contractual obligations, which delay the adjustments.



- Industrial production drops on impact.
- The fast drop can be explained by reductions in capacity utilization and inventory holdings. The latter are reduced to fulfil shipments related to pre-existing orders.

Monetary Policy Transmission: Prices and Wages

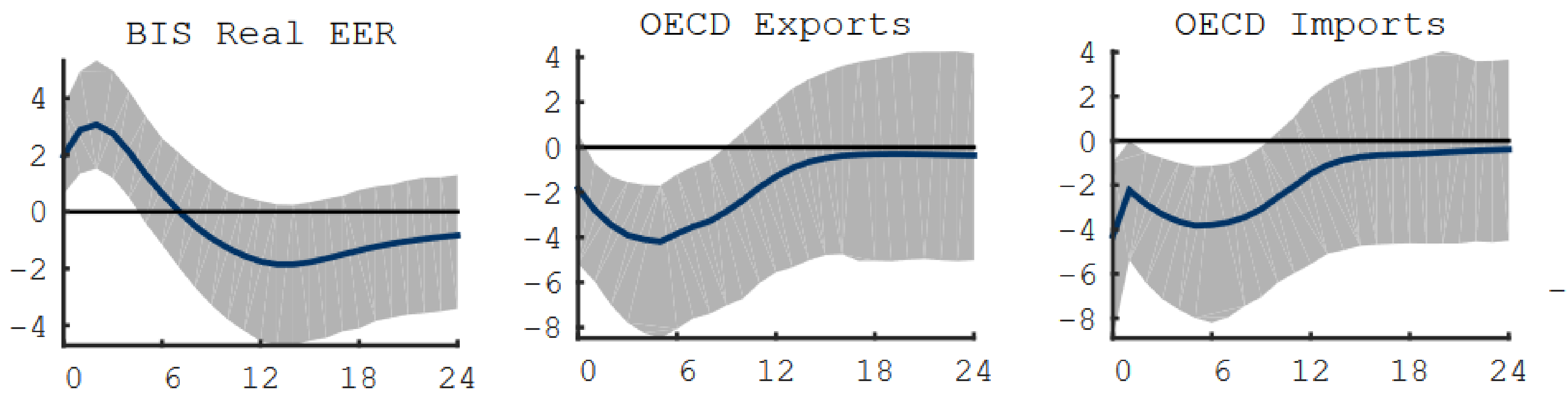


- Prices (measured using CPI or PCE) decline on impact and further slide over a few month.
- Wages decline in a sluggish fashion, estimation uncertainty is high
- In line with models of nominal rigidities

Monetary Policy Transmission: Financial Markets

- The stock market suffers losses
- Housing investment collapse, with peak contractions at the 10% mark
- Yields go up, but less with increasing maturity. No increase in long-term yields
- Risk premia increase
- Evidence for asset price and credit channel (risk premia → financial accelerator)
- Large real effects of monetary policy might be explained by the fact that households suffer from adverse labor market and financial market dynamics

Monetary Policy Transmission: Exchange Rate Channel



- Dollar appreciates in real terms against a basket of foreign currencies
- Exports become more costly and contract as a result
- Notwithstanding the stronger purchasing power sustained by the appreciation of the domestic currency, imports decrease, too
- Exports fall more than imports, so that net exports fall
- Evidence for exchange rate channel

8.3 The Zero Lower Bound

The Zero Lower Bound (ZLB) on Nominal Interest Rates

- So far, we have assumed that there is no restriction to interest rate setting. Via the MP curve, interest rates can go up and down without restrictions.

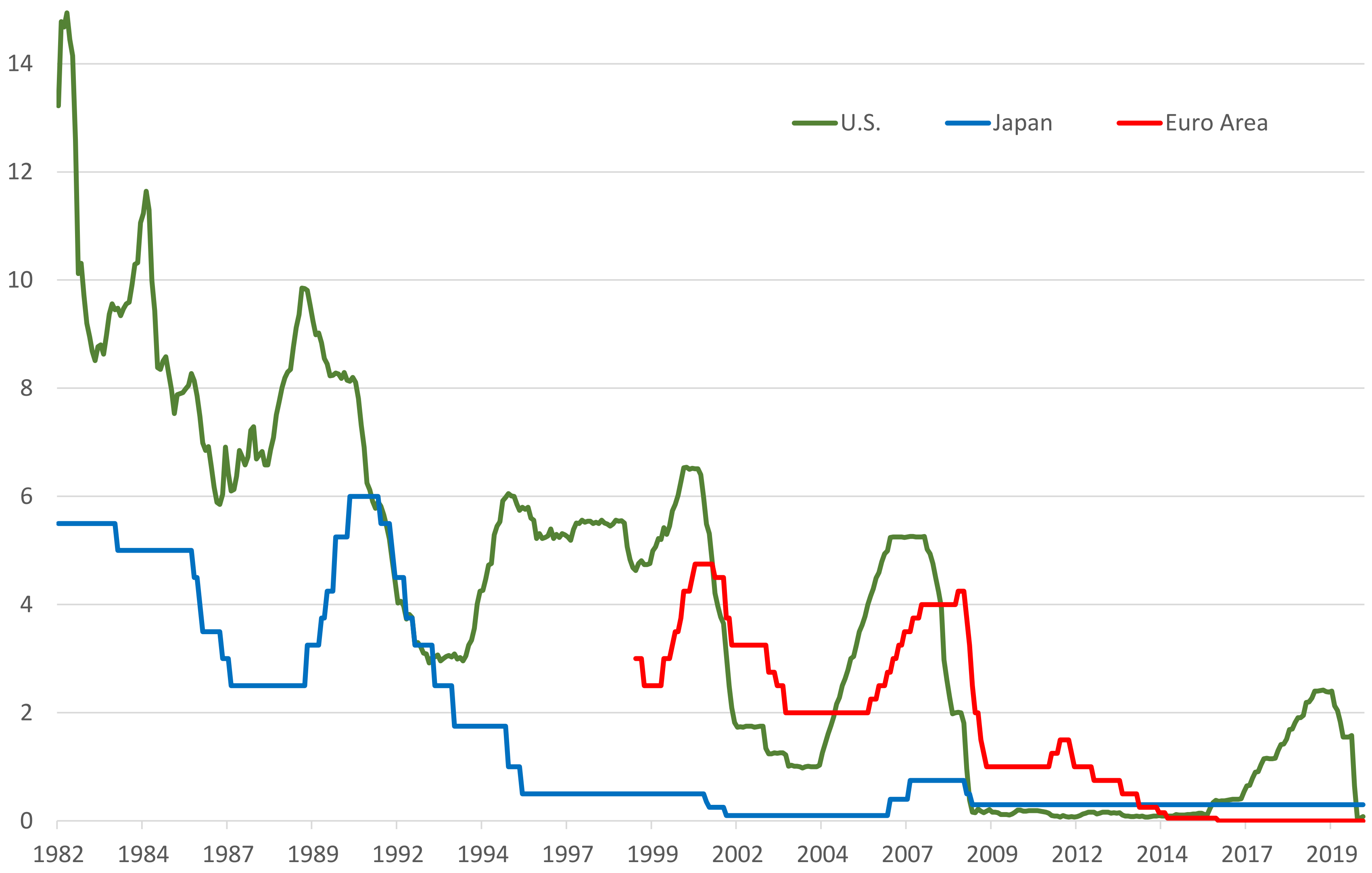
$$i_t = r^* + \pi^* + \beta_\pi(\pi_t - \pi^*)$$

- However, nominal interest rates cannot fall far below zero, as holding cash with an implicit interest of zero percent is always an alternative to depositing money at banks. The effective lower bound (ELB) might be somewhat lower than zero as storing cash has some costs like buying a safe or paying guards. As the ELB is not far below zero, we assume in the following that the lower bound is at zero.
- Since the Global Financial Crisis in 2008/2009 many central banks have reached the zero lower bound (ZLB) on nominal interest rates. In Japan, the interest rate has been close to zero for even longer.
- The zero lower bound leads to a variety of problems in stabilizing inflation and the output gap. Dealing with this situation – also known as liquidity trap - has become the key challenge of central banks.
- Hence, a more realistic policy rule is

$$i_t = max\{r^* + \pi^* + \beta_\pi(\pi_t - \pi^*)\ , 0\}$$

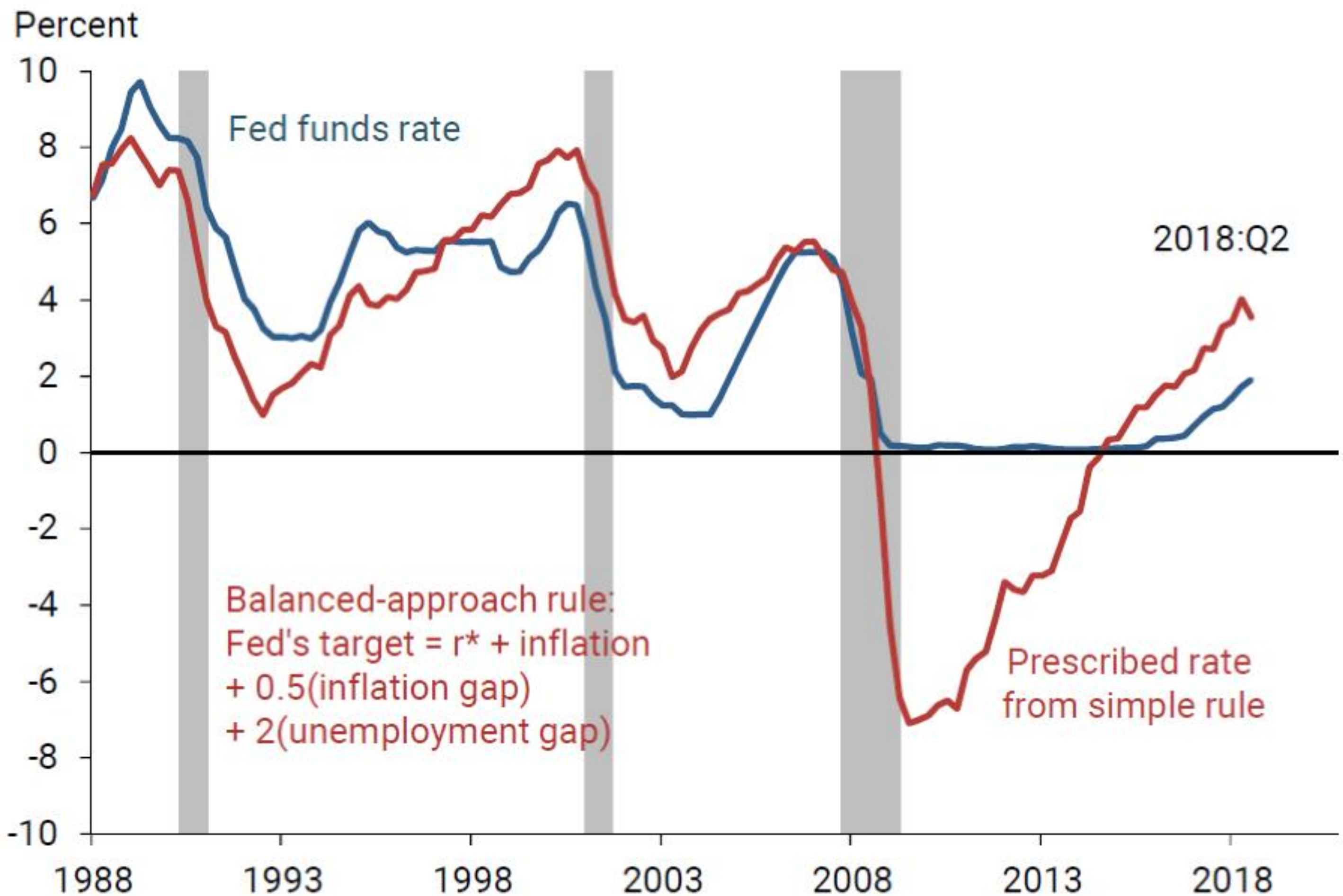
- We are going to adapt our model to consider the possibility of hitting the ZLB.

Policy Rates of Major Central Banks



Source: Fred St. Louis, Bundesbank, Bank of Japan, own computations

Federal Funds Rate and Policy Rule Implied Rate



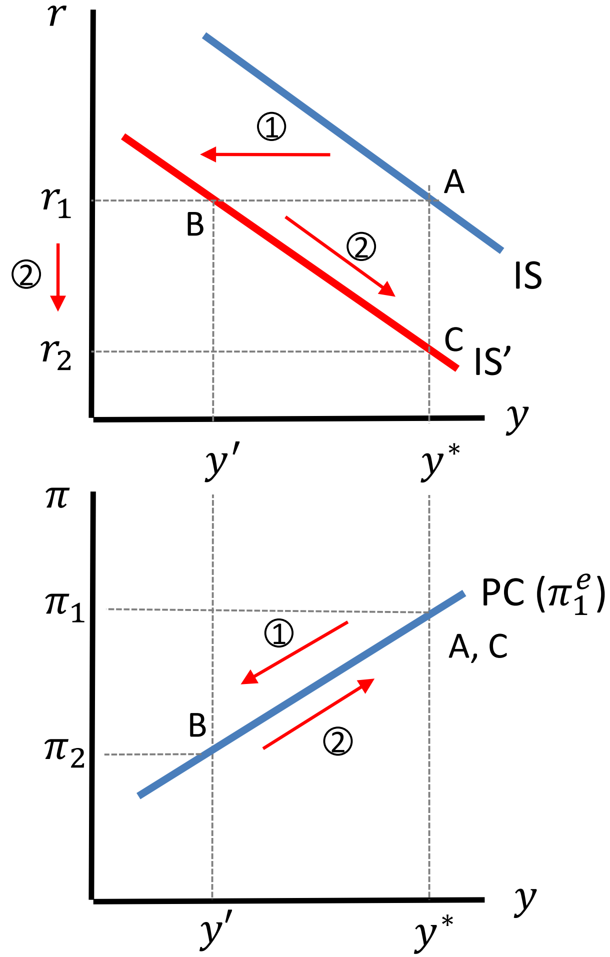
Source: Rudebusch (2018)

IS-PC Model: Demand Shock Without ZLB

Next lecture we will consider the full model with MP curve, today we will see how the IS-PC model with exogenous interest rate setting changes with a binding ZLB

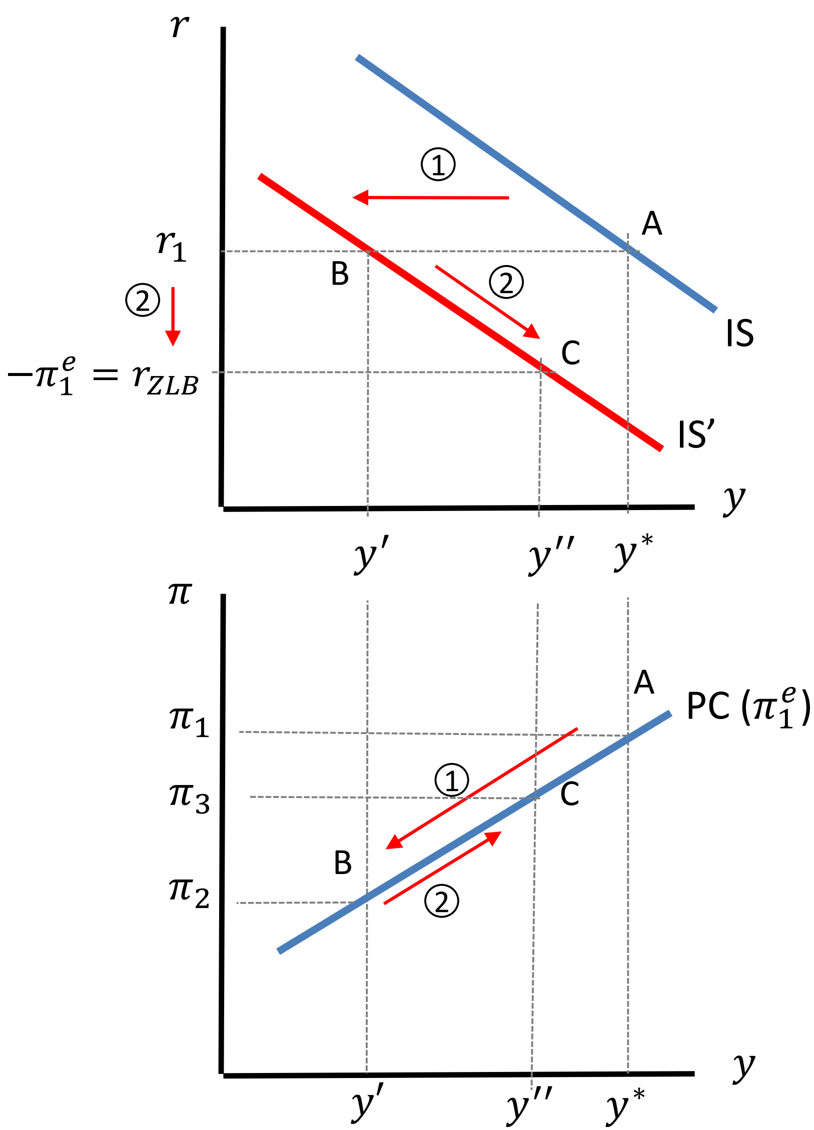
$$\pi_t = \pi_t^e + \gamma\,(y_t - y^*) + \varepsilon_t^\pi$$
$$y_t = y_t^* - \alpha(r_t - r^*) + \varepsilon_t^y$$

Negative demand shock without ZLB: central bank can fully stabilize output and inflation:



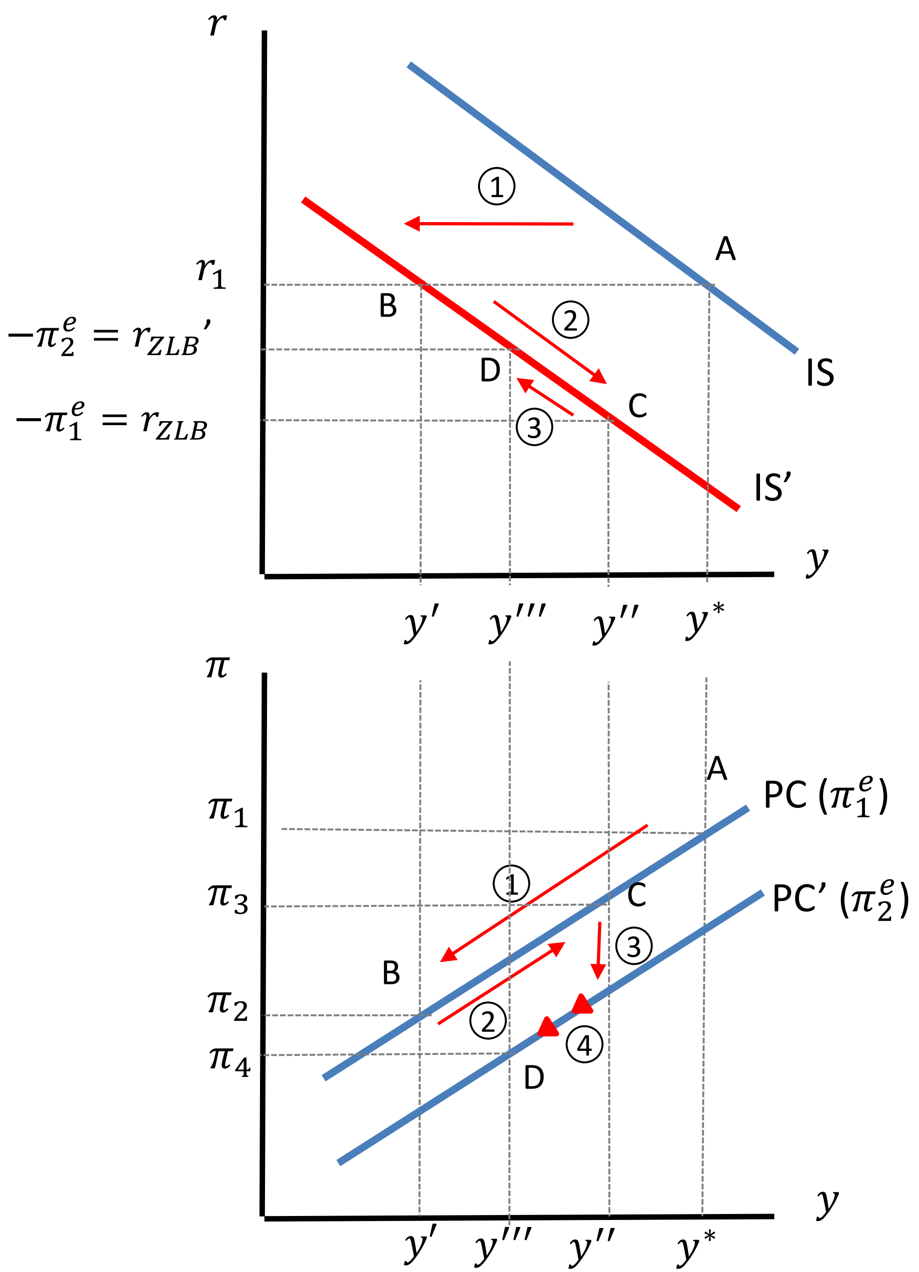
IS-PC Model: Demand Shock With ZLB

With ZLB, the real interest rate has a lower bound: $i_t = r_t + \pi_t^e \quad \Rightarrow \quad r_t^{ZLB} = -\pi_t^e$



- The central bank cannot fully stabilize output and inflation as the central bank cannot lower the real interest rate sufficiently.
- The economy moves to point C, where output and inflation are lower than the equilibrium levels, and the real rate is stuck at its lower bound level.

IS-PC Model: Deflationary Spiral



- If the shock does not fade out fast enough, inflation expectations adjust downwards, shifting down the Phillips curve. Inflation falls.
- The fall in inflation expectations further increases r_t^{ZLB}, so that output shifts further down, decreasing inflation further.
- A deflationary spiral has started. The decrease inflation and inflation expectations, the increase in r_t^{ZLB} and the decrease in output continue and reinforce each other. The Phillips curve continues shifting downwards.

Summary

- Term structure theory: expectations of future short-term rates + term premium
- Monetary policy transmission: interest rate channel, asset price channel, risk channel, credit channel, exchange rate channel.
- The effect of monetary policy shocks on the economy can be estimated empirically, but their correct identification is problematic
- During the last years, many central banks have reached the zero lower bound (ZLB)
- At the ZLB negative shocks cannot be stabilized using conventional monetary policy, possibly leading to a deflationary spiral.