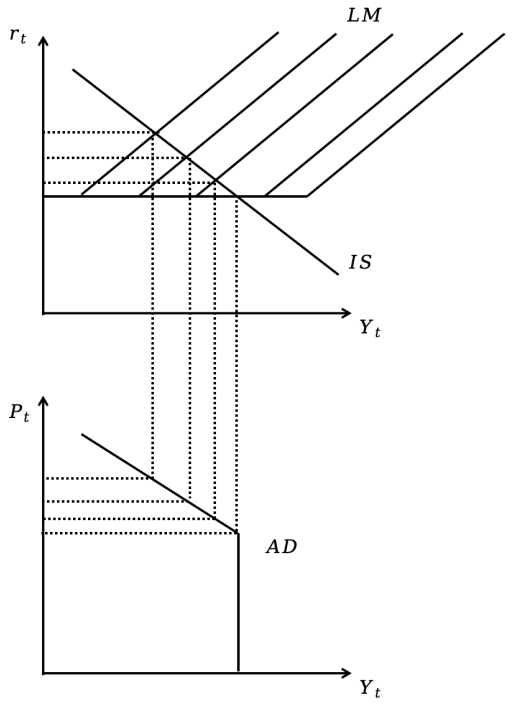
1 ZLB

1.1 ZLB

- The nominal interest rate is given by: $i_t = r_t + \pi^e_{t+1}$
- The nominal interest rate cannot fall below zero: $i_t \geq 0$
- As a result, the real interest rate cannot fall below $-\pi^e_{t+1}$: $r_t \geq -\pi^e_{t+1}$
- This constraint alters the shape of the LM curve

1.2 IS-LM-AD with ZLB

- The ZLB changes the shape of the LM curve: the left segment of all LM curves becomes flat.
- The AD curve is determined by the intersection of the IS curve with a set of LM curves.
- On the non-binding (where the ZLB is not binding), the AD curve slopes downward as usual; on the binding segment, the AD curve becomes vertical.



Overview of the Binding Zero Lower Bound (ZLB) Case:

- The LM curve becomes flat.
- The aggregate demand (AD) curve is vertical.

Case Analysis:

- **Negative IS shock** (IS curve shifts left):

  - When the LM curve is flat, a leftward shift of the IS curve causes the vertical AD curve to shift left.
  - Output decreases, the price level falls, and the real interest rate remains unchanged.

- **Positive supply shock** (AS curve shifts right):
  - Output remains unchanged, the price level decreases, and the real interest rate remains unchanged.

Figure 29.6: Sticky Price Model: Negative IS Shock with Binding ZLB

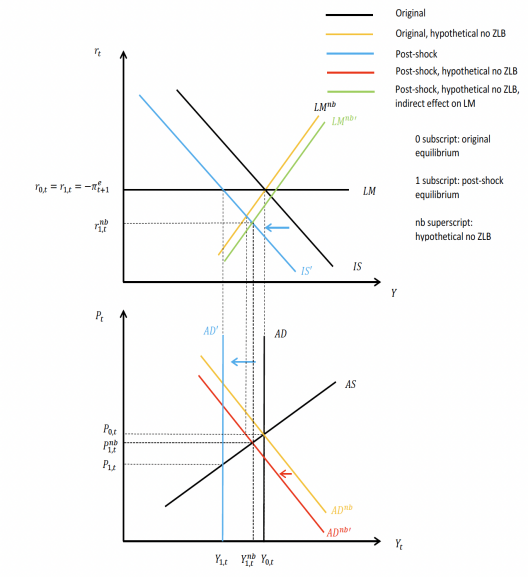
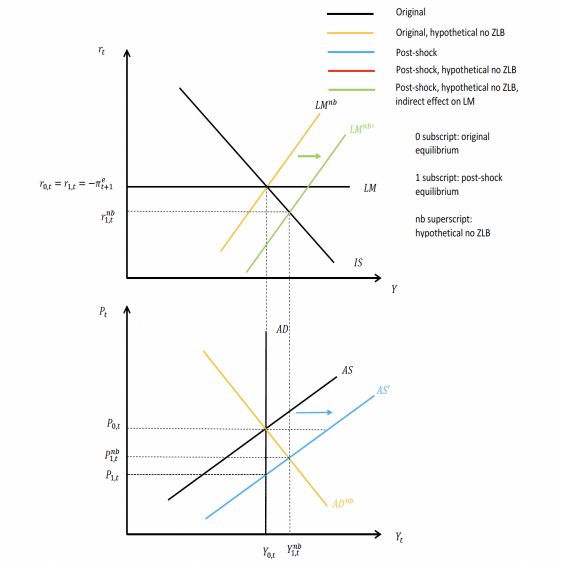


Figure 29.7: Sticky Price Model: Positive Supply Shock with Binding ZLB



1.3 Costly Zero Lower Bound (ZLB)

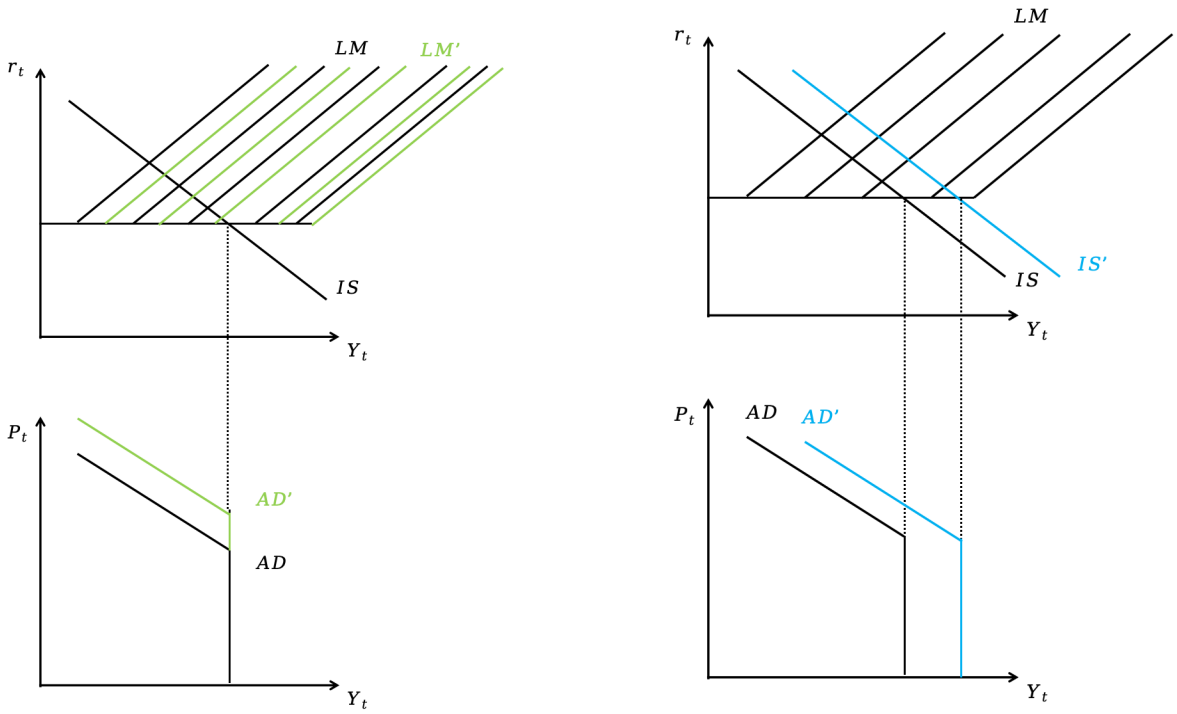
- Conventional monetary policy (i.e., adjustments to the money supply) doesn't work. (Turn to the fiscal policy)
- The self-correcting mechanism of the economy doesn't work.

Conventional monetary policy fails to stimulate the economy. When the money supply increases:

- All LM curves shift to the right.
- The intersections between the IS curve and the LM curves on the non-binding segment move to the right, while there are no intersections on the binding segment.
- As a result, the downward-sloping portion of the AD curve shifts to the right, whereas the position vertical segment remains unchanged. The price level at the kink point goes up.
- On the binding segment, the AD curve does not shift in response to changes in the money supply. Thus conventional monetary policy doesn't work.

The self-correcting mechanism fails under the ZLB. A shift in the AS curve does not restore the economy to the medium-run equilibrium:

- Suppose there is a positive IS shock, and prior to the shock, the economy is at the medium-run equilibrium and constrained by the ZLB. In this case, the AD curve is vertical and coincides with the AS^f curve.
- The positive IS shock shifts the AD curve to the right, making it parallel to the AS^f curve. Regardless of how the AS curve shifts, it cannot bring the economy back to the medium-run equilibrium.



2 Unconventional monetary policy(UMP)

2.1 Why unconventional monetary policy?

- The short-term policy interest rate reaches the **zero lower bound (ZLB)**, limiting the effectiveness of conventional monetary policy.
- **Long-term interest rates matter**: Even when the short-term rate is at zero, long-term rates may remain **too high** to stimulate investment and economic activity.

UMP is used to **influence long-term interest rates** when the ZLB constrains traditional policy tools.

2.2 The mechanism to adjust long-term interest rate

$$i_{nt} = \frac{(i_{1t} + i^e_{1t+1} + \cdots + i^e_{1t+n-1})}{n} + tp_{nt}$$

- i_{nt}: Long-term interest rate. The nominal interest rate on an n-period bond at time t.

- i_{1t}: One-period nominal interest rate at time t, set by the central bank as the policy rate (e.g., the federal funds rate). Under ZLB, i_{1t} is zero
- $i^e_{1t+1}, \ldots, i^e_{1t+n-1}$: Market expectations. The expected future short-term interest rates over the next $n-1$ periods.
- tp_{nt}: The term premium for holding an n-period bond. It compensates investors for the uncertainties over the long holding period.

Long-term interest rate depends on the short-term interest rate, future expectations, and the term premium. UMP adjusts the components of the long-term interest rate to adjust long-term interest rate then stimulate the economy.

2.3 How Unconventional Monetary Policy Works

- **Quantitative Easing (QE):**
  - Indirectly adjusts the long-term interest rate i_{nt}
  - **How:** The central bank purchases, in large quantities, non-traditional securities such as longer-term government bonds or private-sector debt, and injects reserves into the banking system.
  - **Mechanism:** Increasing demand for long-term bonds raises their prices and lowers their yields. Since bond yields reflect i_{nt}, this reduces long-term interest rates even when the short-term rate is at the zero lower bound.
- **Forward Guidance:**
  - Adjusts expected future short-term rates $i^e_{1t+1}, \ldots, i^e_{1t+n-1}$, and thereby affects i_{nt}
  - **How:** The central bank communicates its intention to maintain low short-term interest rates for an extended period.
  - **Mechanism:** Long-term interest rates reflect the average of expected future short-term rates. By lowering expectations of future rates, forward guidance pulls down long-term yields in the present.
- **Credit Easing (CE):**
  - Adjusts the term premium tp_{nt}
  - **How:** The central bank shifts the composition of its balance sheet toward riskier or illiquid assets (e.g., corporate bonds or asset-backed securities) instead of risk-free government bonds.
  - **Mechanism:** By directly purchasing riskier assets, the central bank reduces credit spreads and increases the availability of credit in targeted markets. This lowers the term premium tp_{nt}, helping reduce the long-term interest rate i_{nt}.

3 Term spread

3.1 Present Value Equation of a Bond

- Yield to maturity (r_t) on an m-period coupon bond satisfies the following present value expression:

$$P^B_t = \frac{CO}{1+r_t} + \frac{CO}{(1+r_t)^2} + \cdots + \frac{CO}{(1+r_t)^m} + \frac{FV}{(1+r_t)^m}$$

- The price of a bond is negatively correlated with its yield to maturity (YTM).
- If $P_t^B = FV$, the coupon rate equals the YTM. (Hint: Sum of geometric series; Coupon = FV $*$ Coupon rate)
- The yield curve plots bonds' YTM against their maturities at a given point in time.

3.2 Term Structure Theory of Interest Rate

- **Expectation Hypothesis**
  - Bonds of different maturities are perfect substitutes.
  - The interest rate on a long-maturity bond is approximately equal to the average of expected short-term interest rates.
  - The yield to maturity (YTM) of an N-period bond is:

$$i_{N,t} = \frac{1}{N}\left(i_{1,t} + i_{1,t+1}^e + \cdots + i_{1,t+N-1}^e\right)$$

- **Liquidity Premium Hypothesis**
  - The interest rate on a long-maturity bond equals the average of expected short-term rates plus a term premium.
  - The yield to maturity (YTM) of an N-period bond is:

$$i_{N,t} = \frac{1}{N}\left(i_{1,t} + i_{1,t+1}^e + \cdots + i_{1,t+N-1}^e\right) + \frac{N-1}{N} tp_t$$

3.3 Yield Curve

- A yield curve plots the yields of certain bonds (with identical risk, liquidity, and tax considerations) against different maturities.
- According to the expectation hypothesis, the slope of the yield curve reveals the market's expectations about future short-term interest rates:
  - A rising yield curve indicates that short-term interest rates are expected to increase in the future.
  - An inverted yield curve (negative slope) suggests that short-term interest rates are expected to decline in the future.
  - A downward-sloping yield curve may signal an upcoming recession. Since markets expect future short-term interest rates to fall(Because central banks usually cut interest rates in response to economic slowdowns).