In Chapter 5, we looked at the determination of output in the short run. In Chapter 6, we looked at the determination of output in the medium run. We are now ready to put the two together and look at the determination of output in both the short run and the medium run.

To do so, we use the equilibrium conditions for all the markets we have looked at so far–the goods and financial markets in Chapter 5, the labor market in Chapter 6.
Then, using these equilibrium conditions, we derive two relations: The first relation, which we call the aggregate supply relation, captures the implications of equilibrium in the labor market; it builds on what you saw in Chapter 6.

The second relation, which we call the aggregate demand relation, captures the implications of equilibrium in both the goods market and financial markets; it builds on what you saw in Chapter 5. Combining these two relations gives us the AS-AD model (for aggregate supply- aggregate demand).

Aggregate Supply (AS)

The aggregate supply relation captures the effects of output on the price level. It is derived from the behavior of wages and prices. Recall the equations for wage and price determination from chapter 6:

$$W = P^e F(u,z)$$

$$P = (1+\mu)W$$

Derive the AS relation:

Step 1: Eliminate the nominal wage from the wage setting relation and the price setting relation, then

$$P = P^e(1+\mu)F(u,z)$$

In words, the price level depends on the expected price level and the unemployment rate. We assume that μ and z are constant.

Step 2: Express the unemployment rate in terms of output:

$$u = \frac{U}{L} = \frac{L-N}{L} = 1-\frac{N}{L} = 1-\frac{Y}{L}$$

Therefore, for a given labor force, the higher is output, the lower is the unemployment rate.

Step 3: Replace the unemployment rate in the equation obtained in step one:

$$P = P^e(1+\mu)F\left(1-\frac{Y}{L},z\right)$$

In words, the price level depends on the expected price level, P^e, and the level of output, Y (and also μ, z, and L, but we take those as constant here).

The AS relation has two important properties:

The first property is that, given the expected price level, an increase in output leads to an increase in the price level. This is the result of four underlying steps:

- An increase in output leads to an increase in employment. $Y\uparrow \Rightarrow N\uparrow$

- The increase in employment leads to a decrease in unemployment and therefore to a decrease in the unemployment rate. $N\uparrow \Rightarrow u\downarrow$

- The lower unemployment rate leads to an increase in the nominal wage. $u\downarrow \Rightarrow W\uparrow$

- The increase in the nominal wage leads to an increase in the prices set by firms and therefore to an increase in the price level. $W\uparrow \Rightarrow P\uparrow$

The second property is that, given unemployment, an increase in the expected price level leads, one for one, to an increase in the actual price level. For example, if the expected price level doubles, then the price level will also double. This effect works through wages:

- If wage setters expect the price level to be higher, they set a higher nominal wage. $P^e\uparrow \Rightarrow W\uparrow$

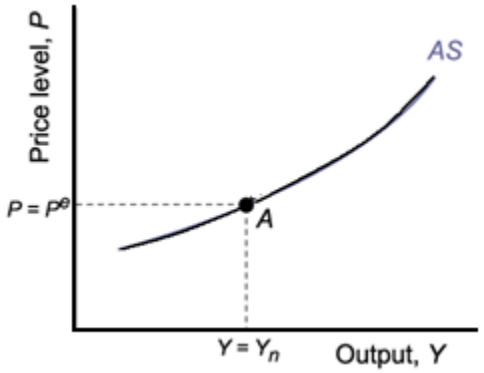
- The increase in the nominal wage leads to an increase in costs, which leads to an increase in the prices set by firms and a higher price level. $W\uparrow \Rightarrow P\uparrow$

The Aggregate Supply Curve

The relation between the price level P and output Y, for a given value of the expected price level P^e, is represented by the curve AS.

The aggregate supply curve is upward sloping: an increase in output leads to an increase in the price level.

Given the expected price level, an increase in output leads to an increase in the price level. If output is equal to the natural level of output, the price level is equal to the expected price level.



The AS curve has three properties that will prove to be useful in what follows:

- The aggregate supply curve is upward sloping. Put another way, an increase in output Y leads to an increase in the price level P.

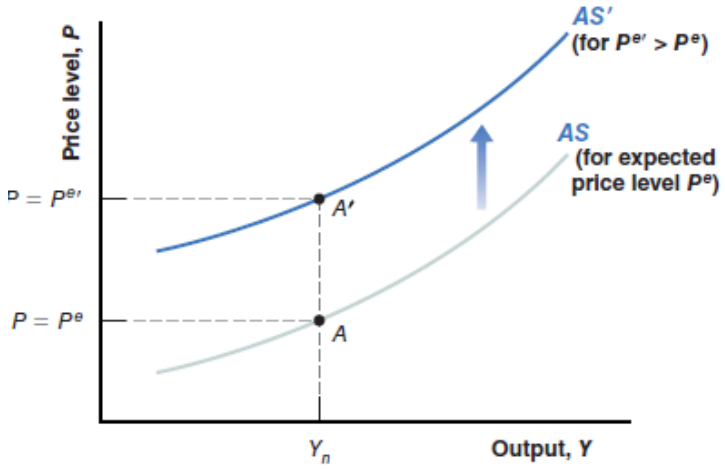
- The AS curve goes through point A, where $Y = Y_n$ and $P = P^e$. This property has two implications:

  When $Y > Yn, P > P^e$.
  When $Y < Yn, P < P^e$.

Shifts in the Aggregate Supply Curve

Any changes in P^e, price of oil (μ), minimum wage (z) or unemployment benefits (z) will shift AS curve.

- An increase in P^e shifts the AS curve up, and a decrease in P^e shifts the AS curve down.
- An increase in price of oil (μ) shifts the AS curve up, and a decrease in price of oil (μ) shifts the AS curve down.
- An increase in minimum wage (z) shifts the AS curve up, and a decrease in minimum wage (z) shifts the AS curve down.
- An increase in unemployment benefits shifts the AS curve up, and a decrease in unemployment benefits shifts the AS curve down.



Example:

The labor market is characterized by the following equations:
$W = P^e(-5 - u + 2Z)$
$P = (1+\mu)W$
$Y = 2N,\ Z = 2,\ L = 200,\ \mu = 0.05$

Where Z stands for unemployment benefits, μ for the markup, P^e for the expected price level, L for the total labor force, N for employment level and u fore unemployment rate

1- Derive the AS curve.

$$P = (1+\mu)P^e(-5 - u + 2Z) \rightarrow P = (1+0.05)P^e(-5 - u + 2*2)$$

$$P = 1.05P^e(-5 - u + 4) \rightarrow P = 1.05P^e(-1 - u)$$

$$u = \frac{U}{L} = \frac{L-N}{L} \rightarrow u = 1 - \frac{N}{L} \rightarrow u = 1 - \frac{Y}{2L}$$

$$P = 1.05P^e\{-1 - (1 - \frac{Y}{2L})\} \rightarrow P = 1.05P^e(-2 + \frac{Y}{2L})$$

$$AS: P = 1.05P^e(-2 + \frac{Y}{400})$$

2- What is the natural level of output in this economy

When $P = P^e \rightarrow Y = Yn$

$$P = 1.05\,P\,(-2 + \frac{Yn}{400}) \rightarrow \frac{P}{1.05P} = -2 + \frac{Yn}{400} \rightarrow 0.95 = -2 + \frac{Yn}{400} \rightarrow 2.95 = \frac{Yn}{400} \rightarrow Yn = 1{,}180$$

3- What is output level in the short run, if $P = \$4$ and $P^e = 2$?

$$P = 1.05\,P^e\,(-2 + \frac{Y}{400})$$

$$4 = 1.05\,(2)\left(-2 + \frac{Y}{400}\right) \rightarrow 4 = -4.2 + \frac{2.1Y}{400} \rightarrow 8.2 = \frac{2.1Y}{400} \rightarrow 3280 = 2.1Y \rightarrow Y \approx 1562$$

Aggregate Demand (AD)

The *aggregate demand relation* captures the effect of the price level on output. It is derived from the equilibrium conditions in the goods and financial markets.
Recall the equilibrium conditions for the goods and financial markets described in chapter 5:

$$IS\ relation:\ Y = C(Y - T) + I(Y,i) + G$$

$$LM\ relation:\ \frac{M}{P} = YL(i)$$

Equilibrium in the goods markets required that output equal the demand for goods- the sum of consumption, investment, and government spending. This is the IS relation.

Equilibrium in the financial markets required that the supply of money equal the demand for money. This is the LM relation.

The Derivation of the Aggregate Demand Curve:

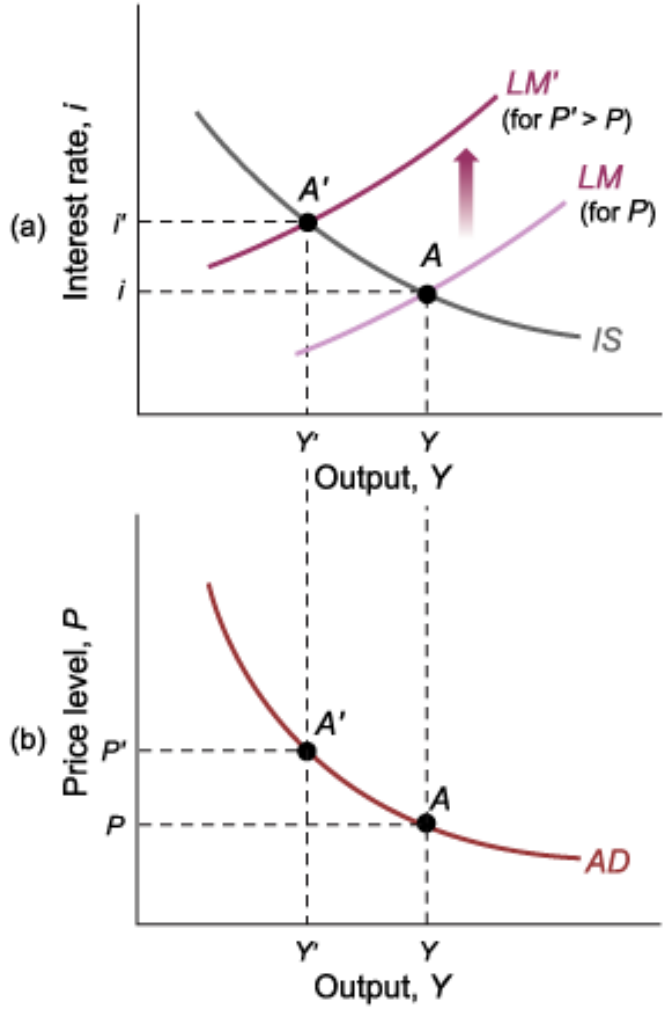
Using the IS and the LM relation, we can derive the relation between the price level and the level of output implied by equilibrium in the goods and financial markets.

Consider the effects of an increase in the price level from P to P'. Given the stock of nominal money (M), the in the price level, decrease the real money stock (M/P). This implies that the LM curve shift up: At a given level of output, the lower real money stock leads to an increase in the interest rate. The equilibrium moves from A to A'; interest rate increases from i to i', and output decreases from Y to Y'. In short, the increase in the price level leads to a decrease in output.

$$\uparrow P \rightarrow \downarrow \frac{M}{P} \rightarrow i\uparrow \rightarrow \downarrow demand \rightarrow \downarrow Y$$

In words: The increase in the price level leads to a decrease in the real money stock, which leads to an increase in the interest rate. The increase in the interest rate leads to a decrease in the demand for goods and to a decrease in output.

The negative relation between output and the price level is drawn as the downward-sloping AD curve.

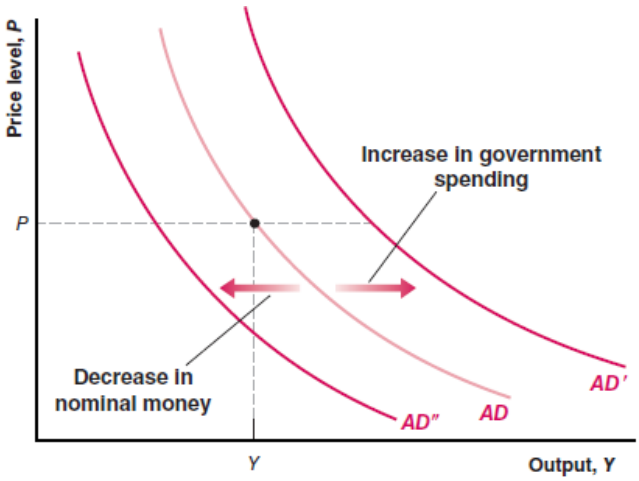


Shifts of the Aggregate Demand Curve

Any variable other than the price level that shifts either the IS curve or the LM curve also shifts the AD curve.

AD: $Y = Y\left(\frac{M}{P}, G, T\right)$ $(+, +, -)$

- An increase in government spending (G), increases output at a given price level, shifting the aggregate demand curve to the right from AD to AD'
- An increase in personal taxes (T), decreases output at a given price level, shifting the aggregate demand curve to the left from AD to AD''
- An increase in consumer confidence (C), increases output at a given price level, shifting the aggregate demand curve to the right from AD to AD'
- A decrease in nominal money (M), decreases output at a given price level, shifting the aggregate demand curve to the left



Equilibrium in the Short Run and in the Medium Run

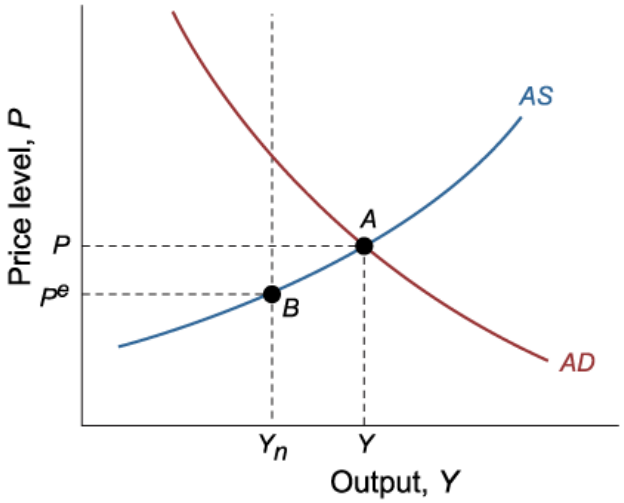
We put together the AS and the AD relations, the two relations are given by:

$$AS\ Relation\ \ P = P^e(1+\mu)F\left(1-\frac{Y}{L},z\right)$$

$$AD\ Relation\ \ Y = Y\left(\frac{M}{P},G,T\right)$$

The Short Run Equilibrium

The equilibrium is given by the intersection of the aggregate supply curve and the aggregate demand curve. At point A, the labor market, the goods market, and financial markets are all in equilibrium.



The aggregate supply curve *AS* is drawn for a given value of P^e. The higher the level of output, the higher the price level. The aggregate demand curve *AD* is drawn for given values of *M, G*, and *T*. The higher the price level is, the lower the level of output.

The equilibrium is given by the intersection of the AS and AD curves at point A. At point A, the goods market, the financial market, and the labor market are all in equilibrium.

There is no reason why, in general, equilibrium output (Y) should be equal to the natural level of output (Y_n). Equilibrium output depends both on the position of the AS curve, and on the position of the AD curve. As I have drawn the two curves, Y is greater than Y_n: the equilibrium level of output exceeds the natural level of output.

The figure above gives our first result: In the short run, there are no reasons why output should equal the natural level of output. *($Y \neq Y_n$)*

When output is equal to the natural level of output, the price level is equal to the expected price level. *(When: $Y = Yn \rightarrow P = Pe$)*

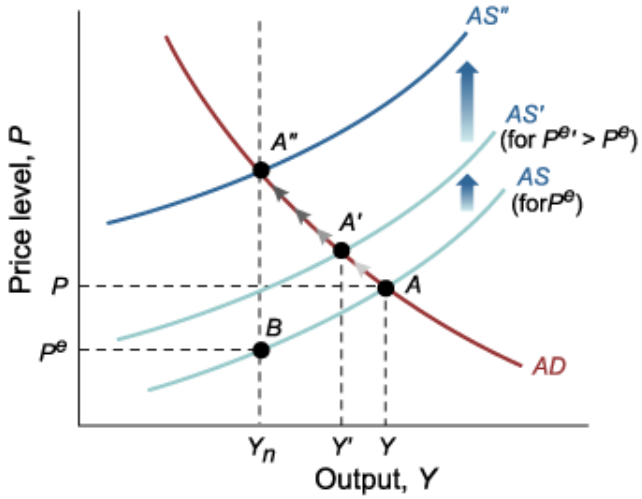
From the Short Run to the Medium Run

At point A, output exceeds the natural level of output. So we know that the price level is higher than the expected price level—higher than price level wage setters expected when they set nominal wages.

At point *A*, $Y > Y_n \Rightarrow P > P^e$

The fact that the price level is higher than wage setters expected is likely to leads wage setters to revise upwards their expectations of what the price level will be in the future. So, next time they set nominal wages, they are likely to make that decision based on a higher expected price level, say, based on $P^{e'}$, where $P^{e'} > P^e$

This increase in the expected price level implies that, next period, the aggregate supply curve shifts up, from AS to AS': At a given level of output, wage setters expect a higher price level. So they set a higher nominal wage, which in turn leads firms to set a higher price. The price level increases.



In words: The fact that output initially exceeds the natural level of output leads to an increase in the expected price level: This expectation leads to an increase in nominal wages, which leads to an increase in the price level. This higher price level leads to a decrease in the real money stock. The interest rate increases, leading to a decrease in output.

The adjustment does not end at point A'. At point A', output Y' still exceeds the natural level of output Yn, so the price level is still higher than the expected price level. Wage setters are likely to continue to revise upwards their expectation, price level

This implies that so long as equilibrium output exceeds the natural level of output Y_n, the expected price level increases, shifting the AS curve upward. The adjustment ends when the AS curve has shifted all the way to AS'', when the equilibrium has moved all the way to A'', and the equilibrium level of output is equal to Y_n.

In the short run: $Y \neq Yn$

Medium run: $Y \rightarrow Yn$

Let's summarize:

- In the *short run*, output can be above or below the natural level of output. Changes in any of the variables that enter either the aggregate supply relation or the aggregate demand relation lead to changes in output and to changes in the price level.
- In the *medium run*, output eventually returns to the natural level of output. The adjustment works through changes in the price level.

The Effects of a Monetary Expansion

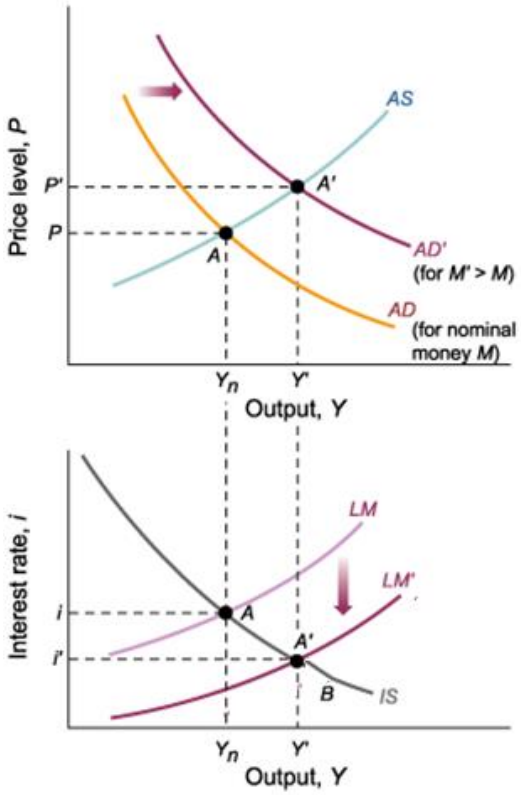
What are the short run and medium run effects of an expansionary monetary policy on output (Y), interest rate (i), price level (P) and investment (I) ?

Assume that before the change in nominal money, output is at the natural level of output, so aggregate demand and aggregate supply cross at point A, the level of output equals Y, and the price level equals P.

The short-run effect:

An increase in nominal money, For a given price level, P, the increase in nominal money, M, leads to an increase in the real money stock, M/P, leads to shifts aggregate demand curve to the right, from AD to AD'.

The monetary expansion shift the LM curve from LM to LM', moving the equilibrium from point A to point A'. The interest rate is lower, output is higher.



In the short run:

Output (Y): Increase from Yn to Y'

Price level (P): Increase from P to P'

Interest rate (i): decrease from i to i'

Investment(I): $Y \uparrow \ \rightarrow I \uparrow$

$i \downarrow \ \rightarrow I \uparrow \ net\ effect\ I \uparrow$

Over time (In the medium run), as output is higher than the natural level of output, the price level is higher than wage setters expected. They revise their expectations, leading the aggregate supply curve to shift up ever time. The economy moves up along the aggregate demand curve AD'. The adjustment process stops when output has returned to the-natural level of output. At that point, the price level is equal to the expected price level. In the medium run, the aggregate supply curve is given by AS", and the economy is at point A": Output is back to Y_n , and the price level is equal to P".

We can actually pin down the exact size of the eventual increase in the price level. Output is back to the natural level of output, the real money stock must also be back it its initial value. In other words, the proportional increase in prices must be equal to proportional increase in the nominal money stock.

Over time, the fact that output is above the natural level of output implies that the price level continues to increase. As the price level increases, it further reduces the real money stock and shifts the LM back up. The economy moves along the IS curve: The interest rate increases and output declines. Eventually, the LM curve returns to where it was before the increase in nominal money.

***In the short run**, a monetary expansion leads to an increase in output, a decrease in the interest rate, and an increase in the price level.*

*Over time, the price level increases, and the effects of the monetary expansion on output and on the interest rate disappear. **In the medium run**, the increase in nominal money is reflected entirely in a proportional increase in the price level; the increase in nominal money has no effect on output or on the interest rate.*

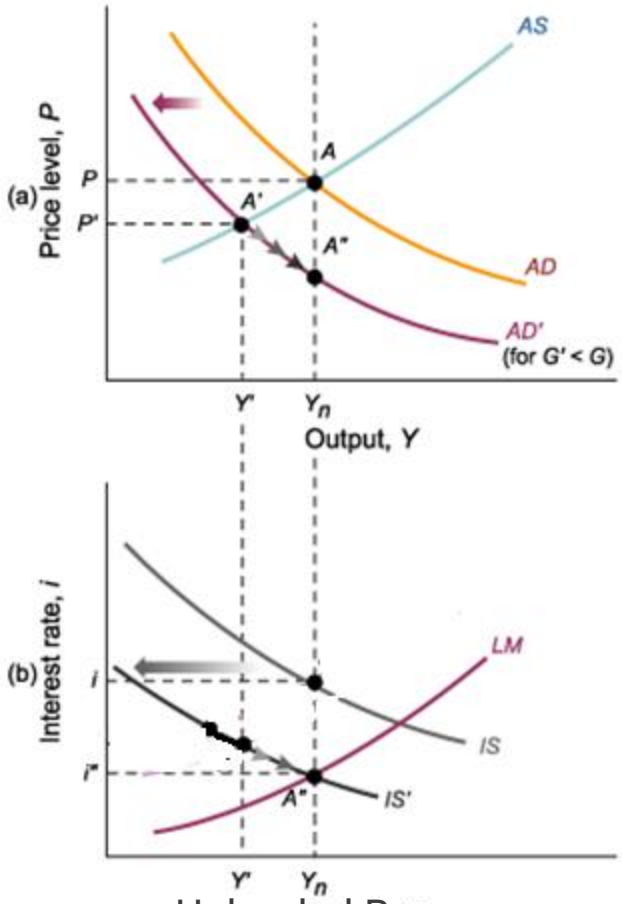
Economists refer to the absence of medium-run effects of money on output and on the interest rate by saying that ***money is neutral*** in the medium run.

The *neutrality of money* in the medium run does not mean that monetary policy cannot or should not be used to affect output: An expansionary monetary policy can, for example, help the economy move out of a recession and return faster to the natural level of output.

The Dynamic Effects of a Decrease in the Budget Deficit

Suppose the government decides to reduce its budget deficit by decreasing its spending from G to G' while leaving taxes, (T) unchanged. How will this affect the economy in the short run and in the medium run?

Assume that output is initially at the natural level of output, so that the economy is at point A. Output equals Y_n. The decrease in government spending from G to G' shifts the aggregate demand curve to the left, from AD to AD': For a given price level, output is lower. In the short run, the equilibrium moves from A to A', output decreases from Y_n to Y' and the price level decreases from P to P'



The short run effects:

Output (Y): decrease from Yn to Y'

Price level (P): decrease from P to P'

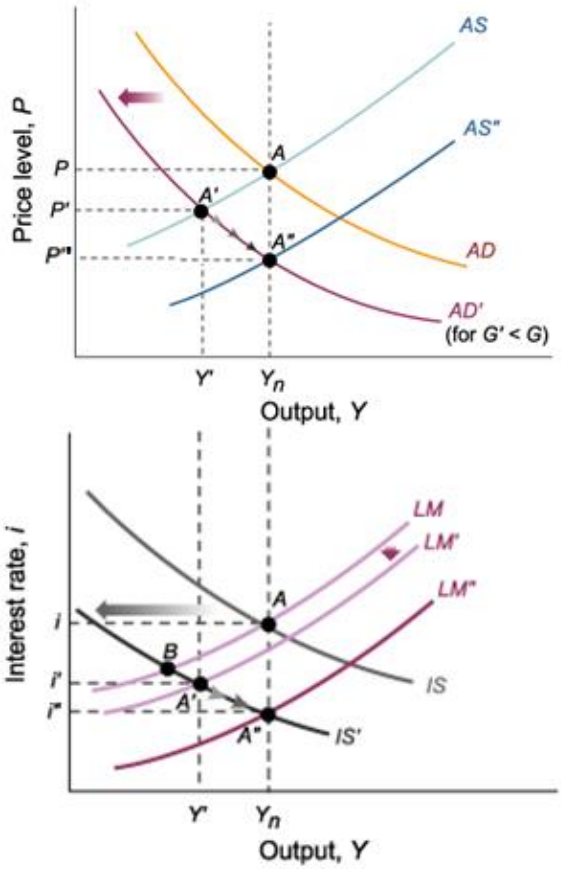
Interest rate (i): decrease from i to i'

Investment(I): $Y \downarrow \rightarrow I \downarrow$

$i \downarrow \rightarrow I \uparrow \; net\ effect\ I : uncertain$

What happens over time? As long as output is below the natural level of output, we know that the aggregate supply curve keeps shifting down. The economy moves down to the aggregate demand curve AD' until the aggregate supply curve is given by AS" and the economy reaches point A". By then, the initial recession is over, and output is back at Y_n.

As the government reduces the budget deficit, the IS curve shifts to the left, to IS'. If the price level did not change (the assumption we made in Chapter 5), the economy would move from point A to point B. But, because the price level declines in response to the decrease in output, the real money stock increases, leading to a partly offsetting shift of the LM curve, down to LM'. So, the initial effect of deficit reduction is to move the economy from point A to point A'; point A' in panel (b) corresponds t point A' in panel (a). Both output and the interest rate are lower than before the fiscal contraction. Note that whether investment increases or decreases in the short run is ambiguous: Lower output decreases investment, but the lower interest rates increase investment.



As long as output remains below the natural level of output, the price level continues to decline, leading to a further increase in the real money stock. The LM curve continues to shift down. In panel (b), the economy moves down from point A' along IS', and eventually reaches A" (which corresponds to A" in panel a]). At A", the LM curve is given by LM": At A", output is back at the natural level of output. But the interest rate is lower than was before deficit reduction, down from *i* to *i"*.

In the medium run:

Output below the natural level of output $(Y < Yn) \rightarrow (P < P^e)$, this leads to decrease in P^e, the aggregate supply curve shifting down. The AS curve continues to shift down until output returns to the natural level of output

As long as a decrease in the price level in the short run, leading increase in the real money stock, the LM curve to shift down (to the right). The LM curve continues to shift down until output returns to the natural level of output

The Medium run effects:

Output (Y): Returns to the natural level of output (Unchanged)

Price level (P): decrease from P' to P''

Interest rate (i): decrease from i' to i''

Investment(I): $Y : unchange \rightarrow I : unchange$

$i \downarrow \rightarrow I \uparrow$ $net\ effect\ I : \uparrow$