We are now in a position to put the demand and supply sides of the model together. This will yield for us the equilibrium price level, level of output, and real interest rate. The equilibrium in the goods market is pictured in Figure 1. If the price level is above $P^*$ in Figure 1, there will be an excess supply of goods. The excess supply of goods will put downward pressure on prices and the price level will fall. On the other hand, if the price level is below $P^*$, then there will be an excess demand for goods and prices will rise. Thus, equilibrium occurs at the price level $P^*$ and level of output $Y^*$.

![Figure 1: Equilibrium](image)

We turn to the money market to study the interest rate and the level of real money balances. We already know that in the long run (a steady state) the real interest rate equals the rate of time preference. This means that the price level, $P^*$, determined in the goods market above, must
leave the supply of real money balances at level that clears the money market with the real interest rate equal to $\rho$. This state in the money market is depicted in Figure 2.

\[ \rho = r^* \]

\[ L(Y, r^*, \pi^e) \]

\[ \frac{M}{P} \]

\[ \frac{M}{P^*} \]

Figure 2: Equilibrium in Money Market

an increase in the money supply

We first look at the effects of an unexpected increase in the money supply. Suppose the money supply increases unexpectedly from $M'$ to $M''$. This shifts the AD curve out and to the right. Since the change in the money supply is unexpected, we assume that increase in the price level to $P'$ is also unexpected. This unexpected increase in prices is interpreted by producers as an increase in their relative price and they supply more output. So, in the short run prices and output increase in response to an unexpected increase in the money supply. Thus, in the short run money is not neutral. This is shown in Figure 3.

What happens to the interest rate? To answer this question, we first note that aggregate demand has increased. What accounts for this increase in desired spending? Aggregate demand depends on the stream of income, factors that affect the MPK, the depreciation rate, the initial capital stock, and the uncertainty of the return to capital. The change in income is unexpected and we assume it is taken to be temporary, so it will have no impact on aggregate demand. None of the other determinants of desired spending listed above changed either. The only remaining
variable that affects aggregate demand is the real interest rate. Hence, the real interest rate must have decreased in order to induce producers and consumers to increase their desired spending.

We can see how this increase came about in Figure 4. The increase in the money supply increases the supply of real money balances and this causes the real interest rate to fall, initially to \( r_1 \). However, this is not quite the end of the story. The price level increases to \( P' \) and output increases to \( Y' \) as a result of the lower interest rate and these changes feedback into the money market. The higher price level reduces the supply of real money balances and the increase in

---

**Figure 3: An increase in the money supply**

We can see how this increase came about in Figure 4. The increase in the money supply increases the supply of real money balances and this causes the real interest rate to fall, initially to \( r_1 \). However, this is not quite the end of the story. The price level increases to \( P' \) and output increases to \( Y' \) as a result of the lower interest rate and these changes feedback into the money market. The higher price level reduces the supply of real money balances and the increase in

---

**Figure 4: Feedback effects in the money market**
real income increases money demand. This causes the real rate to drift up to r'. Since we know that desired spending on goods increased, we know the feedback effect can only partially offset the initial decline in the real interest rate and so r' must be less than r*.

This state of affairs cannot last. Eventually producers will notice the increase in the price level and expectations will adjust. As the expected price level increases, the short run aggregate supply curve will shift back and to the left. Output will fall and prices will rise during this adjustment. This return to the long run with a price level of P** and output Y* is pictured in Figure 5.

In the money market, the increase in the price level to P** returns the level of real money balances to $M'_s/P^* = M''/P^{**}$ and the return of income to Y* returns the money demand curve to its original position. As a result, the interest rate returns to r*, which is the rate of time preference.

*an increase in the riskiness of the marginal product of capital*

Suppose the return to capital becomes more uncertain. This change may occur as the result of political uncertainty, such as the prospect of war or the outcome of a contested and important election, or it may occur as the result of financial uncertainty, such as the fallout following a sharp decline in stock prices. Whatever the cause, and increase in $\sigma$ will directly...
effect investment demand. An increase in uncertainty lowers investment demand and this will shift the AD curve back and to the left. This demand shock will cause the price level to fall. For a given expected price level, the decline in prices will be interpreted by producers as a decline in their relative price and they will cutback output. The price level falls to \( P' \) and output falls to \( Y' \). This shock is shown in Figure 6.

What happens to the interest rate? The decrease in the price level increases the supply of real money balances and this increase will put downward pressure on the real interest rate. The decline in income from \( Y^* \) to \( Y' \) reduces money demand and this decline also puts downward
pressure on the real rate. We can conclude that the real interest rate will decline. This discussion is pictured in Figure 7.

*a temporary increase in the price of oil*

James Hamilton showed that all but one recession in the post WWII era was immediately preceded by or coincident with a sharp increase in the price of oil. An increase in the price of oil raises the cost of production and transportation, and may also disrupt the pattern of production. There are, of course, other shocks, such as bad weather, strikes, and bottlenecks, that increase the cost of production, but oil price shocks usually stand center stage in the discussion of supply shocks. An increase in the cost of production driven by higher oil prices will cause the AS curve to shift back and to the left. This supply shock reduces output and causes an initial shortage of goods and services that pushes up the price level. The effects of this shock are shown in Figure 8.

![Figure 8: Shock to Aggregate Supply](image)

What happens to the interest rate? The increase in the price level will lower the supply of real money balances and put upward pressure on interest rates. The decline in income will reduce money demand and put downward pressure on interest rates. Which effect is stronger? Since equilibrium output falls to $Y'$, we know that desired spending also falls to $Y'$. Now, the
shock to oil prices is temporary, so there is no wealth effect on demand and we also assume that there has been no change in the factors that affect the MPK, the depreciation rate, uncertainty about the return to capital, or the initial capital stock. Thus, the real interest rate is the only factor that affects desired spending that has change and so it must have increased. This result tells us that effect of the decline in income on money demand must be small relative to the change in the supply of real money balances caused by the increase in the price level. This result is pictured in Figure 9.

Shocks can also originate in the money market. For example, an unexpected increase in transactions cost, say as the result of disruption in the banking system, will cause money demand to increase. This increase in money demand will cause the interest rate to rise. The increase in the interest rate reduces consumption and investment demand and the AD curve shifts back and to the left. This decline in aggregate demand causes prices to fall and, since the change in the price level is unexpected, producers will cut back output. A picture of this shock to aggregate demand via the money market looks exactly like the shock pictured in Figure 6.
A shock that originates in investment or consumption demand and causes aggregate demand to fall has the same impact on prices and output as an increase in transactions cost or a decrease in expected inflation. However, there is an important difference in how these shocks affect the interest rate. A negative shock to aggregate demand from, say, an increase in uncertainty will cause the interest rate to fall. On the other hand, a negative shock to aggregate demand from, say, an increase in transactions cost will result in a higher interest rate.

**Conclusion**

In the AD-AS model money is not neutral in the short run. An unexpected increase in the money supply leads to a surprise increase in the price level. Producers misinterpret the increase in prices as an increase in their relative price and increase output. However, in the long run expectations adjust and money is neutral.

The model also allows us to analyze shocks to the economy that originate in investment or consumption demand, money demand, and on the supply side of the economy. If the shock shifts the AD curve, then output and price will move in the same direction. On the other hand, a shock from the supply side will cause prices and output to move in opposite directions.