So far our model has allowed us to study, among other things, how the interest rate and the real wage rate behave. These relative prices are determined in the goods and labor markets, and to study them we did not have to know anything about dollar prices. Up to now, all of the variables that we have discussed are real variables. To study movements in the price level, and hence nominal variables, we need to introduce money into the analysis. The simplest way to integrate money and prices into the model is to rely on the notion of the neutrality of money. The neutrality of money says that a change in the money supply will not affect real variables such as the real rate of interest rate, the level of output, investment, consumption, work effort, real wages, or even real money balances. Instead, an increase in the money supply causes an increase in the price level and nominal wages, and this increase in dollar amounts is just enough to keep the real variables constant.

Many economists do not believe that money is neutral in the short run. Instead, they believe that in the short run a change in the money supply significantly affects real variables, even if only temporarily. In particular, many economists think that an increase in the money supply increases output and employment. They also argue that the short run may be two years long, or longer, and this makes these "temporary" effects very important. The reasons money may fail to be neutral in the short run are somewhat complicated and we will study them later. In any case, you must understand the neutrality of money before you can appreciate its failure.

The introduction of money into the model also allows us to study the effect on prices of shocks to the production function, investment demand, and money demand. This permits us to extend our discussion of oil price shocks, technological shocks, and the like.
Guiding Facts

What is the cyclical behavior of the price level? There appears to be a weak negative relationship between the price level and real GDP growth. The negative relationship is stronger if the Korean War period, 1950-1953, when output and prices both rose sharply, is omitted. The scatter diagram for the post 1954 period is shown in Figure 14.1. Until recently, within the past ten years, most economists believed that prices were procyclical, and this guiding "fact" remains a topic of debate.

Figure 14.2 plots the price level in the U.S. from 1700 to 1995. For the early period the data are rough estimates, but several important features emerge from the picture nevertheless. Prices show no distinct trend from 1700 until the end of World War I. Wars are associated with spikes in

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he price level, but after every war, up until World War II, the price level fell at the end of hostilities. Some of the post-war deflation were lengthy, for example after the Civil War prices declined until the turn of the century. The price behavior after WWII has differed from our earlier experience. Not only did prices fail to fall, there has been a sustained increase in the price level. We will return to this change later.

**The Equilibrium Price Level**

To determine the economy's equilibrium price level, we first find the equilibrium rate of interest and output. This is done, just as before, in the first panel of Figure 14.3. The demand for money depends on real income, the real rate of interest, transactions costs, and the expected rate of inflation. To keep things as simple as possible, we assume the latter two are constant so once $r^*$ and $Y^*$ are known, we can find the demand for nominal money balances. The money demand curve, $M^d$, curve in Figure 14.3, is drawn or positioned on the basis of an interest rate of $r^*$ and a level of real income $Y^*$.

We take the money supply as given. It is just the total value of currency outstanding in the economy. This means that the $M^s$ curve is vertical.

We now have both money demand, $M^d$, and the nominal supply of money, $M^s$, so we can find the equilibrium price level, $P^*$. We do this by first finding the equilibrium $(1/P)^*$ which is done in the second panel of Figure 14.3.
The equilibrium occurs where the $M^d$ curve crosses the $M^s$ line. This, of course, comes as no surprise, but let's stop to see if it makes sense. Suppose the price level is initially $P^l$ as pictured in Figure 14.4. At $P^l$ there is an excess supply of money. What do households do when they have an excess supply of money? Naturally enough, they spend it. The increased dollar spending causes sellers to raise prices, $P$ increases, and $1/P$ decreases towards equilibrium. On the other hand, if the initial price level is $P^h$, the reverse occurs. Households cut back on spending to raise their money holdings. This reduction in dollar spending causes firms to lower prices and again the price level moves toward $P^*$. So, there are forces at work in the economy that move the price level towards its equilibrium.

We found the equilibrium price level in two steps. First we found $r^*$ and $Y^*$ from the goods market diagram and then we found $P^*$ from the money market diagram.\textsuperscript{22} The real variables, output and the interest rate in the goods market graph, can be determined first without knowing the price level. After the real variables are determined, then we can find the price level. This two-step procedure is called the classical dichotomy.

**Price Level Effects from Money Market Shocks**

A money market shock is a change in the money supply or a change in money demand caused by a change in transactions cost. We will assume that the money supply is controlled by the government and is changed by distributing new money to households through lump sum transfers. With lump sum transfers the amount of new money that a household receives is independent of its particular characteristics (for example, its income or bond holdings). This way of changing the

\textsuperscript{22} Actually we found $1/P^*$, the cost of holding one dollar in terms of current goods, but this is equivalent to finding $P^*$. 
money supply is sometimes called a "helicopter" drop of new money. When the government wants to change the money supply it flies over the countryside and randomly drops money out of a helicopter. Those below gather the new cash as it lands.  

a. change in the money supply

How do changes in the money supply through helicopter drops affect the economy? Our graphical analysis represents an increase in the money supply by a shift in the $M^s$ curve to the right. This causes an initial excess supply of nominal money balances, the excess supply of money causes the price of money, $1/P$, to fall, and this means that the price level $P$ rises.

Intuitively, right after the helicopter drop households have more money than they want to hold. Each household tries to reduce its excess supply of money balances by spending it. But one household can reduce its money holdings only by getting another household to increase its. This attempt by all households to reduce their money holdings results in greater dollar spending on goods. When sellers recognize the rise in spending, they raise the price of their goods, and attempt to hire more labor to increase production. The increase in dollar spending on labor raises the nominal wage. In the end nominal wages rise by the same percent as prices, and the real wage remains the same as do employment and output.

In our analysis an increase in the price level will not change the interest rate, output or any other real variable. The independence of real variables from changes in the money supply is called the neutrality of money. At first, neutrality may seem a bit odd. When sellers receive a higher price for their goods aren't they better off? And shouldn't this lead to higher spending by the sellers and then

23 In a modern economy the money supply is changed when the central bank, the Federal Reserve System in the United States, buys government bonds. We will study this mechanism later.
shouldn't the higher spending lead to higher interest rates and so forth? To see the error in this line of reasoning, you must remember that all sellers, including the sellers of labor, are increasing their prices. Individual sellers are not getting ahead when they raise their price, they are just keeping up. In the end it all washes out. Everyone is charging higher nominal (dollar) prices and wages, and holding higher nominal money balances, but in real terms nothing has changed. Figure 14.5 illustrates the effect of an increase in the money supply.

Let's look a bit closer at this result. Equilibrium in the money market requires that the quantity of money supplied equal the quantity of nominal money balances demanded. In symbols this means

\[ M^s = P \cdot L(r^*, Y^*, \gamma, \pi^e). \]

We know that \( r^* \) and \( Y^* \) do not change, and we are holding transactions costs and expected inflation constant. This means, for instance, that if the money supply doubles, the price level must double as well so that we would have

\[ (2M^s) = (2P) \cdot L(r^*, Y^*, \gamma, \pi^e). \]

In general, the neutrality of money means that the price level changes by the same percentage amount as the change in the money supply.

b. a change in transactions costs

Now let's look at the effect of an increase in money demand caused by an increase in transactions cost. Suppose, for example, that the government restricts competition in the banking industry by limiting the number of branches and the number of ATM machines that a bank may operate. Households must now walk or drive farther to get cash, this raises \( \gamma \), the transactions cost, and this raises the demand for money.

An increase in money demand shifts the \( M^d \) curve out and to the right, and this creates an initial excess demand for money. Each household tries to add to their money balances by cutting back on their dollar spending. But one household can add to their money holdings only by getting
another household to reduce theirs. This attempt by all households to increase their money holdings results in a decrease in nominal spending on goods and this causes sellers to lower prices.

Since all sellers are lowering their prices, any individual seller is not losing when she lowers hers. In the end, it again all washes out. Everyone is charging lower nominal (dollar) prices. Though close, this shock is not quite neutral. Since the money supply is constant, the decrease in the price level increases the supply of real money balances. The increase in the supply of real money balances satisfies the increase in money demand that set off this adjustment, and, since a real variable has changed, means a shock to money demand is not neutral. This analysis is summarized in Figure 14.6.

**Price Level Effects from Goods Market Shocks**

We now turn to the effects of shocks in the goods market on the price level. A goods market shock is a shift in the production function or a shock to investment demand. Let's start with a temporary negative shock to the economy's production function caused by, say, an interruption in the supply of raw materials because a major port must close due to hurricane damage. Our earlier analysis tells us that such a shock will cause output to decline and the interest rate to rise. Since output is down, not as many purchases are going to be made and the need for money is reduced. The rise in interest rates also induces households to conserve on money holdings in order to reduce their interest opportunity cost. So, both of these changes reduce the demand for money.

This means that the nominal money demand curve, $M^d$, shifts downward and to the left. This creates an initial excess supply of nominal money balances and the "price" of money, $1/P$, falls or, in other words, the price level rises. The increase in the price level occurs for the same reasons.

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24 Later, we also include changes in fiscal policy in this list.
here as it did when the initial excess supply was caused by a helicopter drop of new money. For the behavior of the price level, the important thing is the initial excess supply of money, not what caused it. Along with the other effects of a temporary negative shock to the production function, we can now add an increase in the price level. This discussion is summarized in Figure 14.7.

A permanent shock to the production function will also affect the price level. Suppose that a new generation of computers helps factories more closely monitor production and this reduces the number of breakdowns in the machinery. This shifts the production function up. For simplicity we assume that this shift does not affect the profitability of new investment projects. The shift in the production function increases income, and, since the shift is permanent, consumption increases by the same amount. There is no change in the interest rate, but income is higher. This is exactly the same analysis we used earlier.

The increase in income, and hence spending, increases the demand for money. The $M^d$ curve shifts out and to the right creating an initial excess demand for nominal money balances and we know that an excess demand for money leads to a decrease in the price level. This is shown in Figure 14.8.

Now consider an increase in the profitability of investment projects. This increases investment demand. We know that such a shock causes both the interest rate and income to increase. The higher interest rate reduces money demand, while the higher income
increases money demand. Without knowing how large the changes are, and how sensitive money demand is to changes in the interest rate and income, we cannot tell how money demand will change. Since we don't know how the $M^d$ curve will shift, we also cannot tell the effect on the price level; it may rise or fall.

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Table 14.1

Price Level Effects of Real and Nominal Shocks

Money and Prices in the Long Run

We mentioned earlier that after World War II the behavior of the price level changed. Instead of deflation and a return to near pre-war prices, prices rose steadily. Figure 14.9 plots the behavior of the money supply and the price level from 1877 to 1995. The money supply and price level have been "scaled" so that 1948 = 100 (that is, we chose 1948 as the base year). The two series are closely related. One doesn't lie directly on top of the other because the money supply isn't the only determinant of the price level. The economy experiences permanent and temporary shocks to the production function and transactions technology changes over time. However, the money supply leaves a strong imprint on the price level. In particular, the distinct change after the second world war is clear in both series and the timing and nature of the change in the money supply is closely mimicked by the change in the behavior of the price level.
Extensions

We can combine our analysis of the price level with our earlier discussion of exchange rates to develop a simple model of exchange rate determination. First, recall the idea of purchasing power parity that we discussed in chapter 6. Purchasing power parity requires that if the bundle of goods is the same in two countries, say the U.S. and Japan, then the dollar price of the bundle should also be same in both countries. This condition holds in the absence of barriers to trade and transactions costs. In symbols this means that

\[ eP_f = P, \]

where \( e \) is the dollar per yen exchange rate and \( eP_f \) is the dollar cost of the Japanese bundle (here assumed to be the same as the U.S. bundle). We can divide both sides by \( P_f \) to isolate the exchange rate and we get

\[ e = P/P_f \]

From this relationship we can tell that shocks that increase the price level in the U.S., given Japanese prices, cause the exchange rate \( e \) to increase. Since \( e \) is the dollar cost of a yen, this
means that the value of the dollar declines and the exchange rate depreciates. So, for example, an increase in the money supply or a temporary negative shock specific to the U.S. causes the dollar to depreciate. On the other hand, a permanent positive shock or an increase in transactions costs results in an appreciation of the dollar because both of these shocks produce a lower price level in the U.S.

Summary

Shocks to the money market or the goods market change the price level. To find the effect of a shock in the goods market on the price level, we first find its effect on output and the interest rate. These effects are exactly the same as they were before we introduced money into the picture. After finding the changes in output and the interest rate, we then determine the impact of these changes on money demand. If money demand increases, then the price level will fall, but if money demand declines, the price level will rise.

A change in the money supply affects the price level, but not any of the real variables. This result is called the neutrality of money. An increase in the money supply will cause an increase in the price level by the exact same percentage amount. That is, a 10% increase in the supply of money will lead to a 10% increase in the price level. The change in the price level returns the supply of real money balances back to its original level.

An increase in transactions costs causes the price level to fall. The fall in the price level increases the supply of real money balances accommodating the increase in demand. Because real money balances change, a shock to \( \gamma \) is not neutral. Table 14.1 summarizes these results.

REVIEW QUESTIONS

1) Analyze the effect of the following shocks on the interest rate, real output, the price level and real money balances
i) the arrival of affordable electricity to major industrial areas around the turn of the century
ii) the sharp but temporary increase in oil prices in the summer of 1990
iii) an increase in the insecurity among firm owners and managers over the future state of the economy
iv) the legal prohibition on nuclear energy that people perceive to be permanent
v) a decrease in the money supply
vi) the introduction and spread of credit cards

2) We recently heard on the street "When prices rise it's just bad, real bad! I don't want to pay higher prices." Comment.

3) Use Figure 14.2 to guess what the price level would be today if the pre-WWII pattern had persisted. What would have had to happen to money growth in order to mimic this old pattern?