

Macroeconomics: an Introduction

Chapter 8

How the Fed Moves the Economy

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Preview

In Chapter 2 we learned that GDP is the total value of goods and services produced by the economy in response to demand from the household, business, government, and rest-of-world sectors. If the Fed

can cause an increase in the demand for goods from any of these sectors, then it can cause an increase in real GDP, provided firms are willing to produce the additional output. Similarly, if the Fed can dampen demand, then it can reduce real GDP and even cause a recession.

In this chapter we will see how the interest rate becomes the lever with which the Fed moves the demand for goods. We will analyze how a change in the interest rate has its immediate impact on the demand for investment goods (plant and equipment) by the business sector and for durable goods by the household sector. Lower interest rates reduce the cost of buying durable goods such as factories, machines, office buildings, new houses, autos, and major appliances. An increase in the demand for such durables stimulates firms to produce more, thereby boosting real GDP. Conversely, higher interest rates discourage such spending and dampen economic activity.

What happens if interest rates are already so low that we are in the **Liquidity Trap**? As we saw in Chapter 7, there is a limit to how low the Fed can push interest rates before people would prefer to hold additional assets in the form of money instead of bonds. The Fed found itself in this situation in 2009 and in Chapter 9 we will discuss how it attempted to escape the liquidity trap, and whether it was successful in stimulating demand.

Finally, in this chapter we learn what happens if the Fed supplies money at a rate beyond what the economy demands for normal growth. When ‘overheating’ occurs, the level of prices (CPI) increases, ultimately being determined by the quantity of money. This result is called The **Quantity Theory of Money**. Further, if the Fed continues a rapid money growth policy, the rate of inflation will rise in response and ultimately the interest rate will rise in accord with the Fisher equation of Chapter 4.

8.1 The Interest Rate and the Demand for Durable Goods

Imagine that you are running a catering business. As you look at the operations of your business you can see a number of improvements that you could make to reduce costs or increase sales, but they all involve spending money on new equipment or facilities. Having done your MBA you know that the scientific manager makes a list of potential projects, figuring the rate of return on investment or **ROI** for each. Then one ranks the projects by ROI, and usually undertakes those which offer a higher ROI than the cost of capital. But since you haven't really completed an MBA yet, let's find out what all that jargon means with the help of a simple example.

What is the ROI?

Take your two delivery vans for example. They are real junkers and are in the repair shop so much that you could get the same work done

with one new reliable van at considerable savings in employee time and repair bills. A new van costs \$15,000 and you estimate that during the first year you would save \$8,000 in expenses and that the van would have a resale value of \$12,000 at the end of the year. Your investment in the van is \$15,000, while the value received from your investment after one year would be \$8,000 in cost savings plus the \$12,000 resale value of the used van.

The ROI for this van is calculated in the same way that we calculate the yield or return on any investment: the amount gained from the investment as a percentage of the original cost:

$$\text{ROI} = \frac{\text{Amount Gained}}{\text{Amount Invested}} = \frac{\text{Cost Savings} + \text{Resale Value} - \text{Cost of Van}}{\text{Cost of Van}}$$

Putting in the numbers for the delivery van we have:

$$\text{ROI} = \frac{\$8,000 + \$12,000 - \$15,000}{\$15,000} = .33 = 33\%$$

a 33% return on investment. You can think of this as being analogous to the yield on a one-year bond, where \$15,000 is the price of the bond, \$8,000 is the coupon received, and \$12,000 is the face value. The yield on a one-year bond is the return on a financial investment, the ROI is the return on an investment in plant and equipment.

If your catering business has liquid assets that it can invest, then you will want to compare the ROI on a new van to the ROI, or yield, on alternative investments, including bonds. If the yield on one year bonds is 10%, then it is clearly to your advantage to buy the van rather than a bond. The interest rate available on bonds is the opportunity cost of buying the van. If the ROI for the van exceeds your opportunity cost, then you surely will buy the van; you are far ahead earning 33% rather than 10%. Of course, the return on a bond is a certainty if held to maturity, while the return on the van is less certain since you may have overestimated or underestimated the resale value of the new van. You will want to keep this distinction in mind when making the decision whether to purchase the van or a bond.

What if you need to borrow to pay for the van? This is the situation that rapidly growing businesses almost always face. If you can borrow the \$15,000 from the bank for one year at 15%, you will almost surely go ahead and buy the van. The interest rate the bank charges you on the loan is your cost of capital. Projects with an ROI higher than your cost of capital will be advantageous for you to undertake. In practice, the interest rate your firm can earn as an investor in bonds will generally be less than what a bank will charge you for a loan.

A list of possible investment projects in your catering business with the cost and ROI for each might look like this:

Table 8.1: Potential Investment Projects and Their ROIs

<u>Investment in:</u>	Cost \$	ROI
Van	15,000	33%
Freezer	7,500	25%
Pasta machine	2,000	20%
Espresso maker	3,000	15%
Display shelving	12,000	10%
Satellite phone	500	5%

With bank loans costing 15%, you will probably buy the first three items because the ROI in each case exceeds your cost of capital. But you might not buy the espresso maker since you expect it to earn you a return that is only just enough to pay for your bank loan. Given the uncertainty of realizing the estimated ROI in practice, it is perhaps prudent to undertake projects only if their ROI exceeds the cost of capital by an amount that compensates you for the risk you are taking that the project will not work out as well as you hoped.

You almost certainly would not buy the last two items which have ROIs that are less than the cost of capital.

What Happens When the Interest Rate Changes?

What would it take to make you change these decisions? Suppose the interest rate charged by the bank on loans jumped to 22%. Then it is very clear that you would drop your plan to buy the pasta machine, and would certainly not buy the espresso maker. On the other hand, if you could get a loan at only 10% then the espresso maker would be on for sure, and maybe the display shelving too.

But why would the bank change the interest rate it charges on loans? Banks can invest their funds in bonds as well as in direct loans to firms or households. Therefore the interest rate on bank loans must be competitive with other interest rates such as yields on bonds issued by the U.S. Treasury or General Motors Corporation, adjusting for risk of default. Of course, your catering business will be required to pay a higher interest rate than the Treasury or GE because the risk that you might default is perceived to be much higher. Because all of these borrowers compete to attract funds from the same lenders, when interest rates rise or fall there is a tendency for all interest rates to move together: bank loan rates, Treasury bond yields, corporate bond yields, home mortgage rates, and so forth.

That is why economists speak of "the" interest rate influencing the demand for capital goods; there are actually many interest rates, but

they all move together with the benchmark yield on Treasury bonds. This means that the Fed can affect the rate your business pays for a loan simply by its influence on the supply of money through open market operations.

When the Fed expands the money supply, interest rates fall and more investment projects in businesses like your catering firm become attractive to undertake, so spending on plant and equipment rises. *When the Fed contracts the money supply, interest rates rise and many potential investment projects become unattractive, so investment spending falls.*

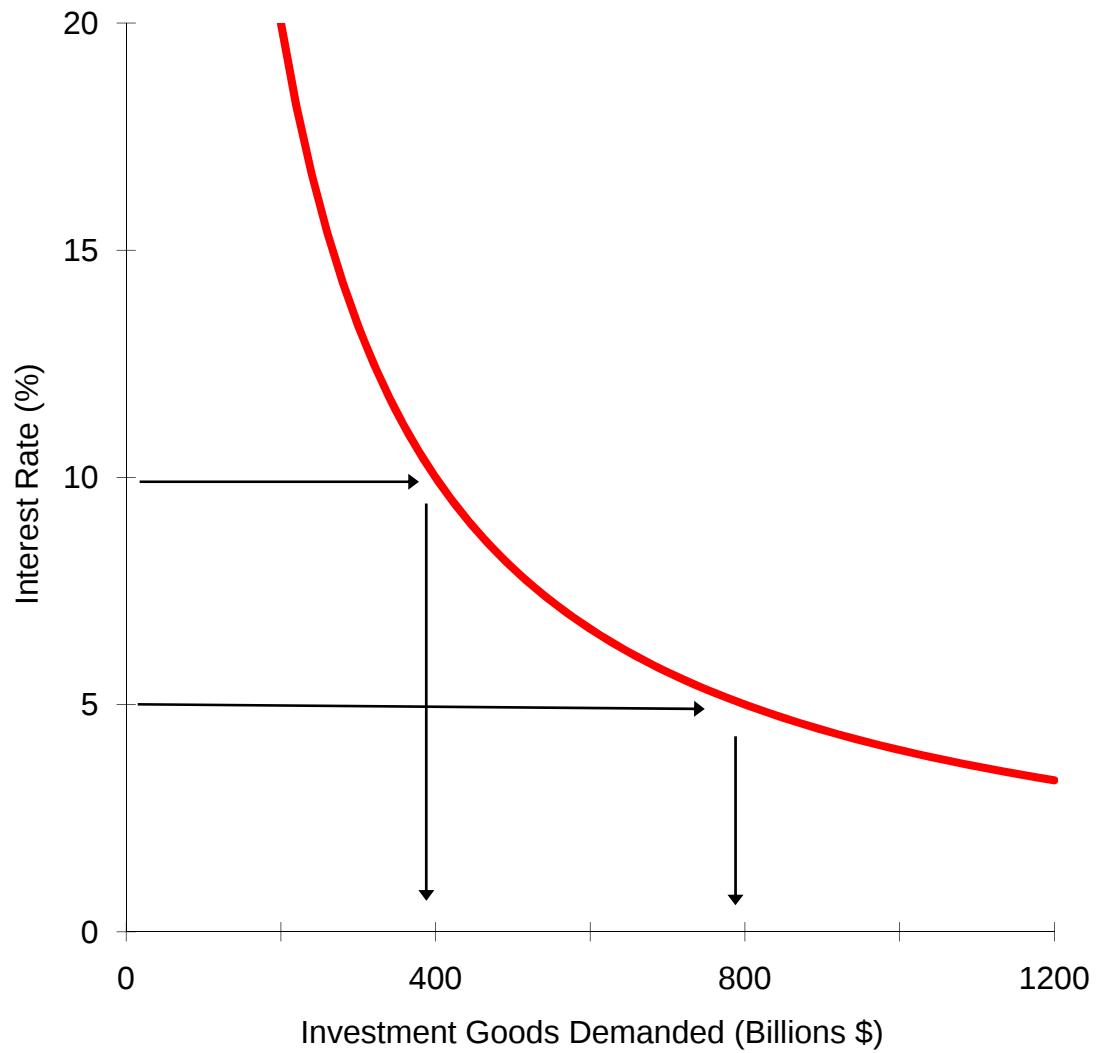
The Demand for New Plant and Equipment

Now let's add up the value of all the investment projects that would be undertaken by all the firms in the economy at each level of the interest rate. For example, at an interest rate of 10% the total might be \$400 billion, while at 5% a total of, say, \$800 billion in investment projects would be undertaken. Plotting these totals with the interest rate (the cost of capital) on the vertical axis and the total dollar value of investment projects on the horizontal axis, we would get a demand curve for investment goods such as we see in Figure 8.1.

Just as the demand for apples is a downward sloping function of the cost of apples, the demand for investment goods is a downward sloping function of the cost of the financial capital used to buy them. At very high levels of the interest rate, there are only a few projects that are worth undertaking. At very low levels of the interest rate there will be many more projects that become profitable.

According to Figure 8.1, at an interest rate of 10% the demand for investment goods is \$400 billion per year, while at 5% the demand is much greater, \$800 billion, because the cost of capital to firms is lower. If the Fed cuts the interest rate from 10% to 5% by increasing the money supply, it provides a \$400 billion boost to the demand for goods in the economy. If, conversely, the Fed pushes the interest rate up from 5% to 10% by reducing the money supply, then it will reduce the demand for goods in the economy by \$400 billion. Of course, these specific amounts are hypothetical, and the actual investment demand curve for the U.S. economy shifts as other economic conditions change. What is important here is the principle that by lowering interest rates the Fed can increase the demand in the economy for capital goods, while by raising interest rates the Fed can diminish the demand for goods.

**Figure 8.1: The Demand for Investment Goods
Depends on the Interest Rate**



Household spending on durable goods such as appliances, cars, and housing is also sensitive to interest rates because these are the capital goods of the household. That new refrigerator that uses half as much electricity as the old icebox, makes ice cubes automatically, and is much more reliable has an ROI just as the delivery van does. As consumers, we usually don't go to the trouble of putting a specific dollar value on such benefits to calculate an ROI, but the same factors influence our decisions. Lower interest rates will make more attractive the purchase of refrigerators, homes, autos and other "consumer durables" which are all investments that provide benefits to the household over a period of time.

To sum up, interest rates are the link between the "monetary economy" of banks and financial markets and the "real economy" of production and employment. The ability to stimulate or dampen the demand for a wide range of goods through its influence on interest rates gives the Fed a very powerful lever to move the economy.

What Happens If the Economy is Caught in a Liquidity Trap?

Just as even strong medicine is not always effective if the disease is too severe, this mechanism for stimulating demand may fail under circumstances where interest rates are already very low so that the potential to move them lower is very limited, and where businesses decision makers are pessimistic about the future and have few projects they deem attractive investments. This was the situation in the **Great Depression** of the 1930s and again, in less severe form, was the situation in the midst of the **Great Recession** in 2009. We learned in Chapter 7 that there can be Liquidity Trap at very low levels of interest rates, meaning that further attempts to push interest rates lower by the Fed will run into resistance from investors who see little advantage to holding bonds over money when the reward is very low. Ultimately, the scope for lower interest rates runs into the lower bound at a rate of zero (a dollar bill pays zero interest, so why would anyone hold a bond paying less than zero?) In the aftermath of the **Financial Crisis** of 2008-09 the Fed cut the rate it charges banks to virtually zero, and the rate on Treasury bonds follow to a historic low of about 4%. However, this was not enough to stimulate investment in new capital goods, plant and equipment, because fear of further collapse in the economy paralyzed business management.

The great economist John Maynard Keynes observing this problem during the Great Depression concluded that the Liquidity Trap was a very real possibility and presented a severe problem and limitation for monetary policy. He concluded that monetary policy was not an adequate tool in a deep recession situation and that an alternative, namely fiscal policy, would need to be used. We discuss his ideas more fully in Chapter 11.

Exercises 8.1

A. By replacing its old personal computers with new powerful workstation computers, an engineering firm estimates it can save 150 hours of an engineer's time per workstation per year. This is because design ideas can be tested with "Cad/Cam" software much more quickly on the faster workstations. Design engineers earn about \$40 per hour including fringe benefits. Workstations lose about half their market value in the first year, and cost \$10,000 when new. What is the ROI to the firm on a new workstation during the first year? If the firm can borrow at 7%, do you think it will buy new workstations? Why?

How would your answer change if the interest rate were instead 10%? Or 15%?

B. How would your answers to A above change if the price of the workstation were cut to \$8,000? How would this explain a boom in investment in computing equipment in spite of stable or even higher interest rates?

C. Although the Fed cut interest rates to near zero in 2009, business spending on plant and equipment failed to increase. Taking one industry as an example (autos are suggested), discuss how this failure can be understood.

8.2 Aggregate Supply and Aggregate Demand

We have seen that if the Fed conducts an open market operation to reduce interest rates by increasing the money supply, the effect will be to increase the demand for capital goods. Microeconomics teaches us to expect two things when demand increases: 1) price rises, and 2) higher price induces firms to produce more. We will see that these two effects also occur at the macroeconomic level: 1) the price level, as measured by a price index, will rise, and 2) output, measured by real GDP, will rise.

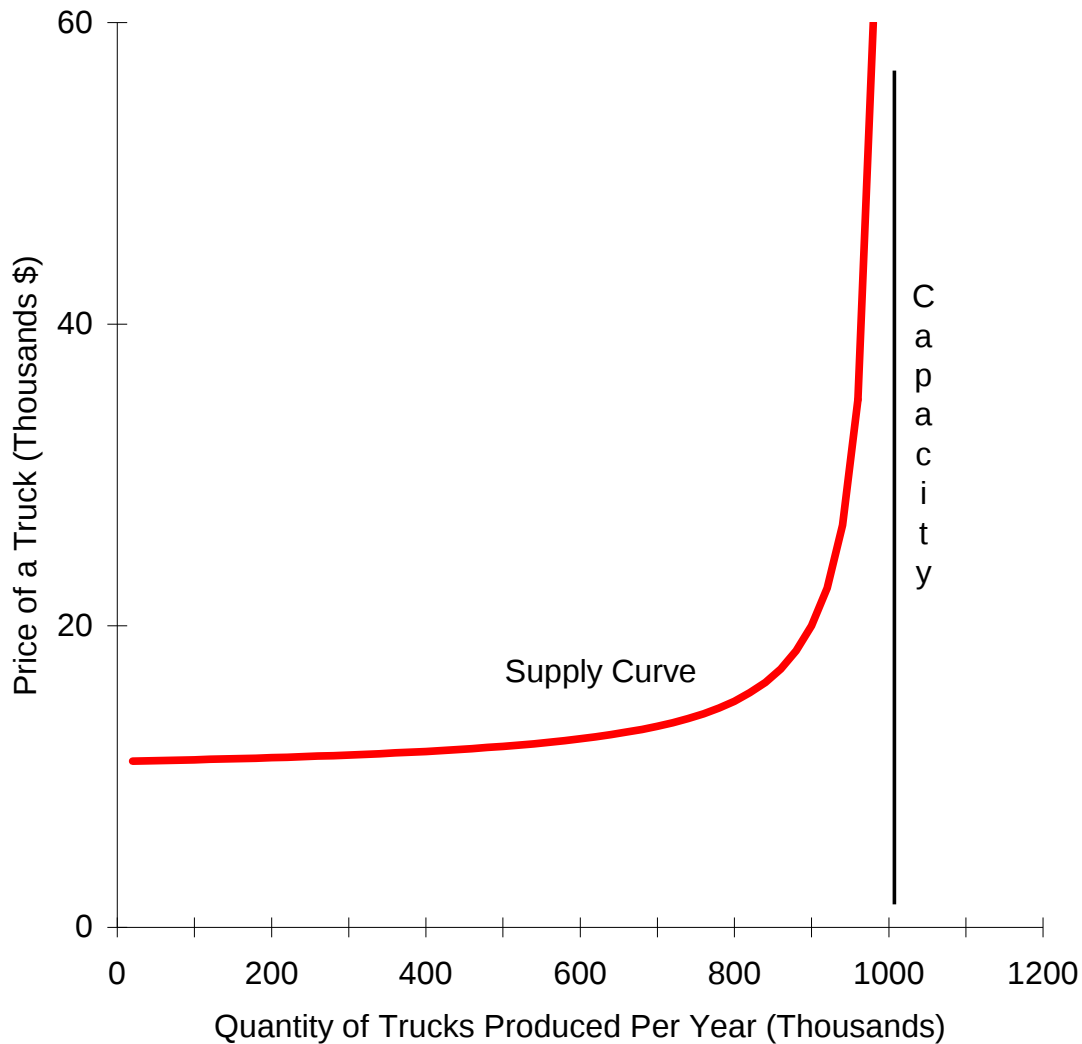
Start at the Micro Level

Let's start by looking at the market for trucks. Figure 8.2 depicts a hypothetical supply curve for trucks, with the price of a truck on the vertical axis and the quantity produced per year on the horizontal axis. A supply curve tells us what price is required to induce the industry to produce a given quantity of the good. The higher the price, the more output is forthcoming from the industry. Why? The marginal (incremental) cost of production rises as the production rate increases because the firm uses its most productive resources first; additional output forces it to use less productive machines and less experienced workers. Because a firm will produce until the marginal cost of producing another unit is just covered by the price it will receive for that unit, a higher price will induce the firm to produce more.

For example, at a price of \$12,500 the truck industry produces 600,000 trucks per year, according to the hypothetical supply curve of Figure 8.2, but if the price is \$15,000 then the industry will boost production to 800,000 trucks per year. But to induce the industry to boost production to 900,000 requires a very big price increase to \$20,000. That is because the marginal cost of production is rising very steeply at higher levels of output. Contributing to these higher cost would be factors such as overtime wages to workers, higher shipping costs to obtain parts from more distant suppliers, a higher rate of wear and tear on machinery, and so forth.

Indeed, there is no price high enough to induce the industry to produce more than about 1,000,000 trucks per year because there are ultimately physical limitations on the ability to produce. Industrial engineers would say that the industry has a capacity of just under a million units. From the perspective of an economist, the important fact is that costs rise very steeply as production rates approach full capacity utilization.

Figure 8.2: The Supply Curve for Trucks and Full Capacity Output



Impact of a Change in the Interest Rate

The impact of a shift in the demand for trucks on the price of trucks and the rate of output of the industry will depend on where demand intersects the supply curve. In Figure 8.3 we have an initial demand curve, the thin line, which intersects the supply curve at point #1.

Recall that the demand curve tells us how many units buyers will purchase at a given price. At lower prices, the quantity demanded is, of

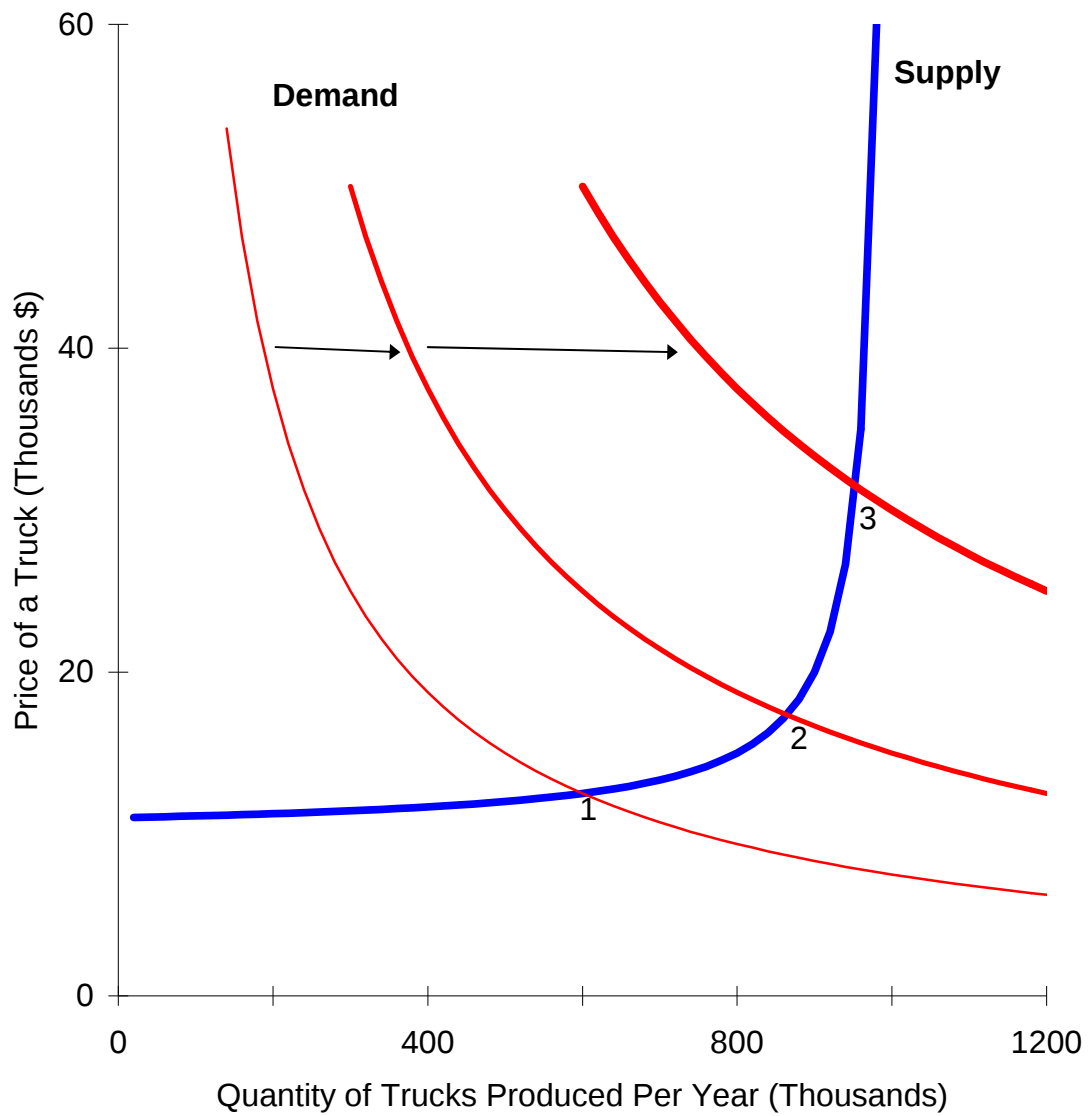
course, greater. The position of the demand curve depends on a number of factors that affect demand, including the interest rate. At point #1 in Figure 8.3, the price is such that purchasers are willing to produce exactly the number of trucks that the firms are willing to produce, so the market is in equilibrium at that price.

If the Fed now acts to cut interest rates, then the quantity of trucks demanded at any given price will increase as potential purchasers compare the ROI on a new truck with the lower interest cost. What we will see in the truck market is rightward shift of the demand curve as shown, with the new equilibrium at point #2. As the market moves from point #1 to point #2 there is a large increase in the quantity of trucks produced and little change in price. That is because in this range the firms can boost their production with only a moderate increase in marginal cost.

If the Fed were then to cut interest rates even further, causing another rightward shift of the demand curve, then the market would move from point #2 to point #3 along a portion of the supply curve where prices are rising very steeply. This second shift has therefore resulted mainly in an increase in the price of trucks with little increase in the quantity of trucks produced.

The impact of each rightward shift in demand is divided between the impact on price and the impact on quantity produced. What we have learned from Figure 8.3, then, is that as production approaches full capacity for the industry, further increases in demand will increasingly result in higher prices and less in higher production.

Figure 8.3: The Market for Trucks



What is the Aggregate Impact on the Macro Economy?

If a change in interest rates affected only the market for trucks then this would be a topic in microeconomics and we would have little more to say about it. What happens, of course, is that a change in interest rates affects the demand for all durable goods so its impact is macroeconomic. We will see that the economy as a whole responds in much the same way to additional demand coming from lower interest rates. If factories and workers are idle then we will see a pickup in production and employment that shows up as an increase in real GDP. But if the economy is already close to full employment with a high level of capacity utilization, then we will see a general rise in prices that is reflected in the CPI and the GDP deflator.

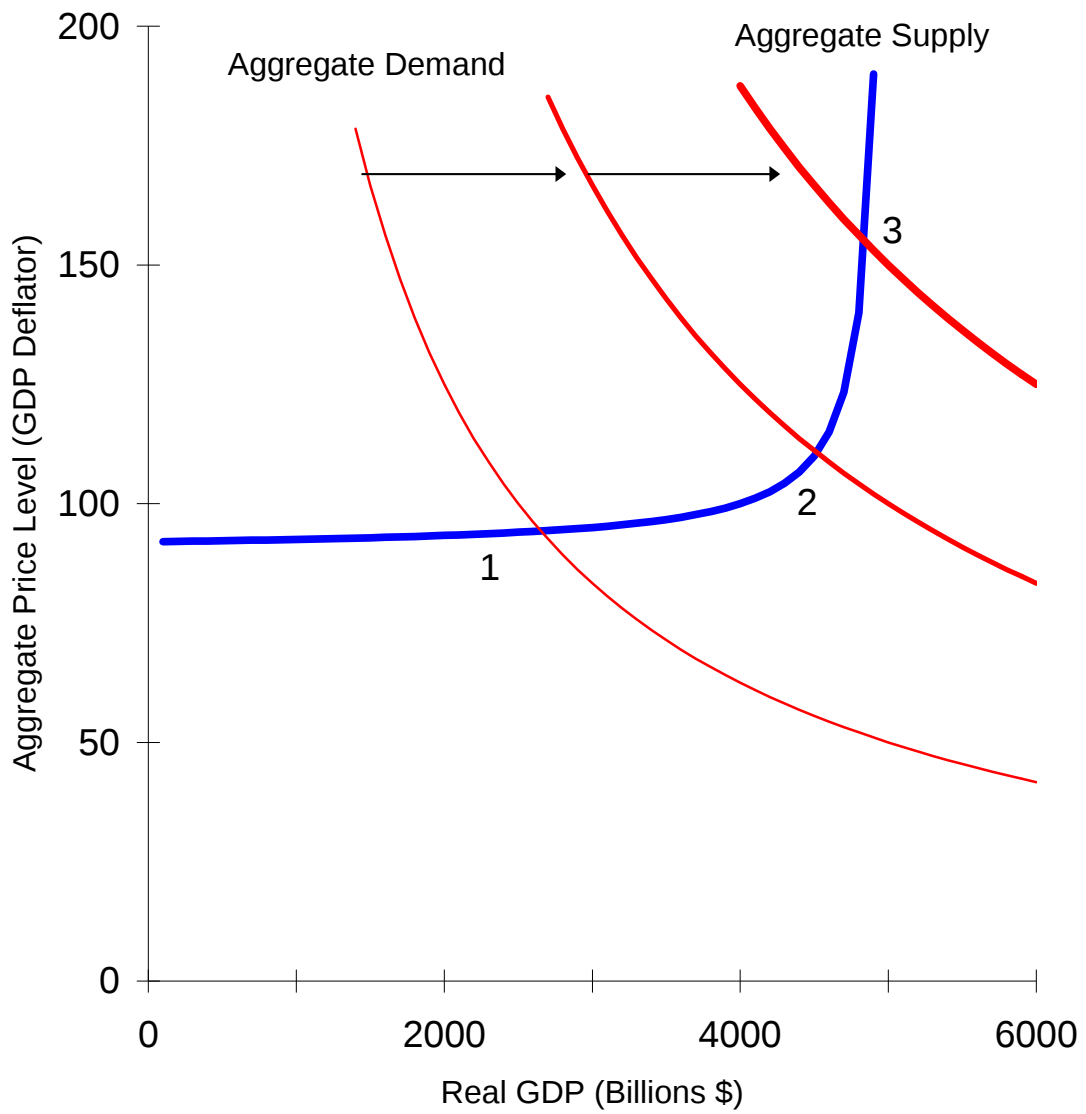
Figure 8.4 shows how these basic relationships can be described graphically as what we call aggregate supply and aggregate demand curves for the whole economy. Instead of the price of a single good on the vertical axis, we have the price level for the economy, measured by the GDP deflator. Instead of the quantity of a good on the horizontal axis, we have the quantity output of the economy, real GDP.

Aggregate supply shows how much real GDP firms in total will produce at a given price level. As in individual markets, there is a full capacity level of output, shown here as a real GDP of \$5,000 billion, at which even very large increases in price will result in no additional output. Aggregate demand shows how much real GDP is demanded by buyers at a given price level. It is clear that if lower interest rates shift the demand curves in individual markets rightward, then the aggregate demand curve will also shift rightward.

At its initial position depicted by the thin line in Figure 8.4, the intersection of the aggregate demand curve with the aggregate supply curve determines the price level and real GDP are at point #1. An increase in aggregate demand caused by the Fed cutting interest rates would correspond to a rightward shift as depicted with a new price level and real GDP at point #2. This shift results mainly in an increase in real GDP rather than in the price level because the aggregate supply curve is relatively flat over this range. However, a further increase in aggregate demand depicted by the thick line produces a very large increase in the price level with little additional output in the economy at point #3.

As in the case of individual markets, the impact of a shift in demand is divided between the impact on the price level and the impact on output. The closer is the economy to full capacity utilization, the greater will be impact of an increase in aggregate demand on the price level, and the less will be its impact on output.

Figure 8.4: Aggregate Supply and Aggregate Demand



If the Fed acts to boost aggregate demand in the midst of a recession, when actual output is well below full capacity, then we would expect the economy to respond much as we saw in the move from point #1 to point #2 in Figure 8.4. Real GDP will rise with little increase in the GDP deflator. On several occasions the Fed has taken just such an action to push the economy out of recession. But if the Fed increases aggregate demand when the economy is already operating at close to full capacity, then we would expect the economy to respond as it does here in the move from point #2 to point #3. In that case there would be little increase in real GDP, but there would be a large increase in prices.

Exercises 8.2

A. Referring to Figures 8.3 and 8.4, depict a further increase in demand, both in the truck industry and in the economy. What might cause a shift like this to occur? What will happen as a result of it in the truck industry and in the economy?

8.3 Full Employment, the Natural Rate of Unemployment, and the Natural Rate of Output

Terms like "full" employment, the "natural" rate of unemployment, and the "natural" rate of output help to earn economics the nickname "the dismal science." How can economists talk about the economy being at "full" employment when millions are out of a job? And how callous of them to refer to unemployment as being "natural!" Certainly no politician could ever be elected after saying that the economy is operating at its "natural" rate of output with no promise for greater prosperity after the election! Of course, by now you know that economics is not dismal at all but actually a lot of fun, and that many everyday terms are used in economics to convey a related but more narrowly defined meaning.

The Labor Market

To develop these concepts we look at the labor market when the Fed is boosting aggregate demand. It may seem insensitive to think about a market for workers as if they were just so many trucks, but the supply of labor and demand for labor do depend on the wage rate and, as in any market, they determine the equilibrium price, the wage. In Figure 8.5 we abstract from the fact that there is a wide range of skill levels and wage levels among workers and instead pretend that there is a homogeneous worker who earns a uniform wage. This simplification is adequate for purposes of our macro analysis.

The supply curve in Figure 8.5 shows the wage rate that is required to induce a given number of workers to accept employment. Notice that some workers would accept employment at even very low wages, but that

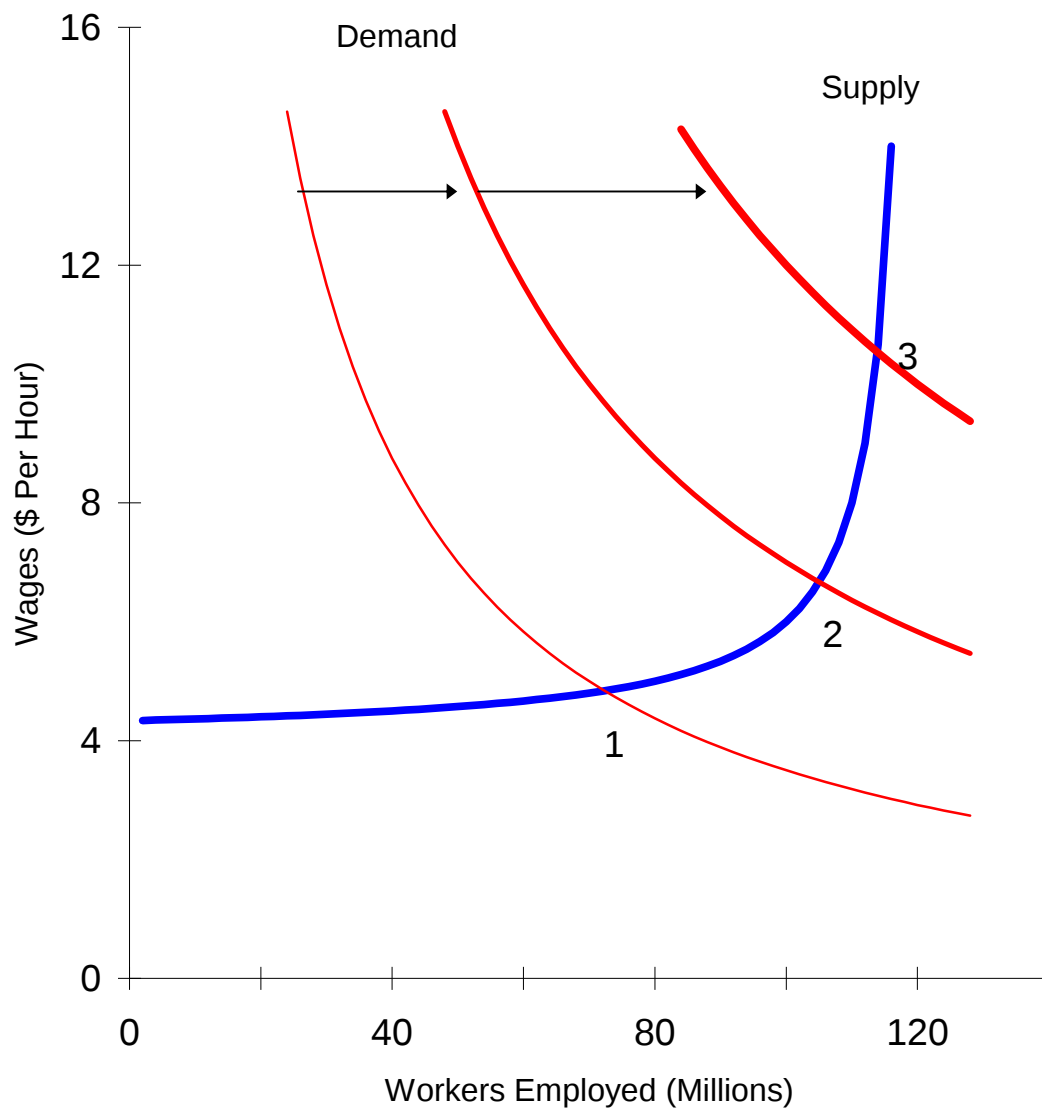
the wage required to induce additional workers to accept jobs rises ever more steeply as the number employed approaches 120 million. At a high enough wage some retired people, homemakers, and students would reenter the labor force, but the total number of adults is ultimately limited. The three demand curves show how a rightward shift in the demand for labor is divided between an increase in the number of workers employed and the wage rate.

From the initial demand curve depicted as a thin line, successive rightward shifts in demand produce less increase in employment and a larger increase in the wage. As employment approaches its hypothetical maximum of 120 million, the equilibrium wage rises very sharply. As in the concept of full capacity utilization for an industry, the concept of full employment in the labor market is not one of absolute physical maximum but rather the range in which the wage would rise very sharply.

When the Fed acts to stimulate the economy by cutting interest rates, the demand curves for durable goods such as trucks shift rightward, consequently aggregate demand in the economy also shifts rightward, and busy firms demand more labor to produce the goods that their customers are demanding. If the economy is in recession when the Fed cuts interest rates, then there is unused capacity in the goods and labor markets and the main effect will be a rise in real GDP with little effect on the price level.

But what if the Fed stimulates the economy when it is already operating close to full capacity and near full employment? From our analysis so far it is clear that there will be little further increase in real GDP or employment, but instead the main effect will be higher prices and wages. But that is not the end of the story. Higher wages and prices will reinforce each other as employers feel the effect of higher wages and households feel the effect of higher prices. The result will be further increases in prices and wages and less of a gain in real GDP and employment, and perhaps none at all.

Figure 8.5: The Labor Market



What If the Economy Is Already At Full Employment?

To see how the impact of a monetary stimulus tends to effect only the price level when the economy is already close to full employment, let's trace through the events depicted in Figures 8.6, 8.7 and 8.8.

Figure 8.6 depicts the market for trucks, with the initial positions of the demand and supply curves shown as thin lines. Now we imagine that the Fed cuts interest rates, stimulating the demand for trucks and other durable goods, so the demand curve shifts rightward to the thick line. Equilibrium in the truck market moves from point #1 to point #2.

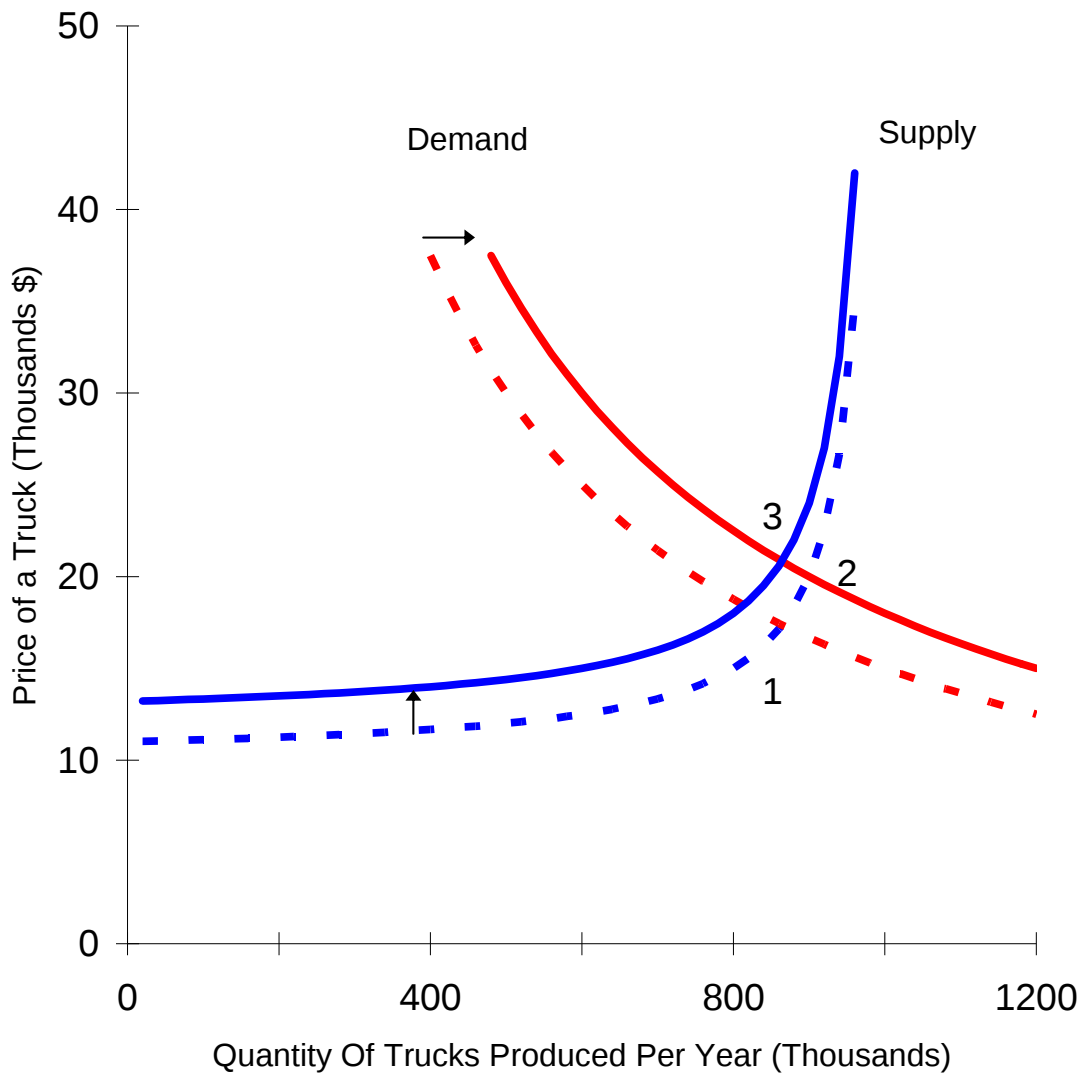
As we saw before, the effect of this shift is to boost both the price and output of trucks, and since the industry is already close to full capacity output, the effect on the price is substantial.

As we work through Figures 8.7 and 8.8 we will find that this is not the end of the story, however. The supply curve will also shift upward, as shown by the thick line, further boosting the price of trucks and causing the output of trucks to fall back to its initial level.

But why does the supply curve shift upward? Recall that the supply curve represents that price that is required to induce the industry to produce a given level of output. When the costs of production rise, a higher price is required to induce the industry to produce trucks, and this is reflected in a higher supply curve. Production costs rise following the Fed's interest rate cut because lower interest rates are stimulating demand in many markets, thereby pushing up the prices of many goods that truck producers use in making trucks. Booming demand for labor is also pushing up wage rates in the labor market, so the cost of the labor input to the manufacturing process is also rising.

The macroeconomic effect of the Fed's interest rate cut is depicted in Figure 8.7, where the initial positions of aggregate supply and demand are shown as thin lines. Aggregate demand shifts rightward as the demand for trucks, airplanes, refrigerators, and thousands of other products is boosted by lower interest rates. The equilibrium in the economy moves from point #1 to point #2, resulting in a substantial increase in the price level in the economy because the economy is already close to full capacity output. Correspondingly, Figure 8.8 shows the initial impact of the Fed's policy change on the labor market where the equilibrium moves from point #1 to point #2, again resulting in a large increase in the price in this market, the wage rate.

Figure 8.6: The Market for Trucks



Now let's take a look again at the truck market in Figure 8.6. Truck manufacturers find that they are paying higher wage rates, that they are paying higher prices for steel (which is in strong demand from makers of a wide range of products), for machinery, and for energy (also in strong demand from a wide range of booming industries). The marginal cost of producing a truck has increased substantially at every level of output. Therefore, the supply curve for the industry shifts up by the amount that costs rise, resulting in a new equilibrium at point #3 at an even higher price but lower output than at point #2.

At the macroeconomic level, the situation is shown in Figure 8.7 where the aggregate supply curve shifts upward, reflecting the fact that costs are rising not only in the truck industry, but also in practically every industry. From its position at point #2, equilibrium moves in the direction of an even higher price level but a reduction in real GDP, to point #3.

Meanwhile, in the Labor Market

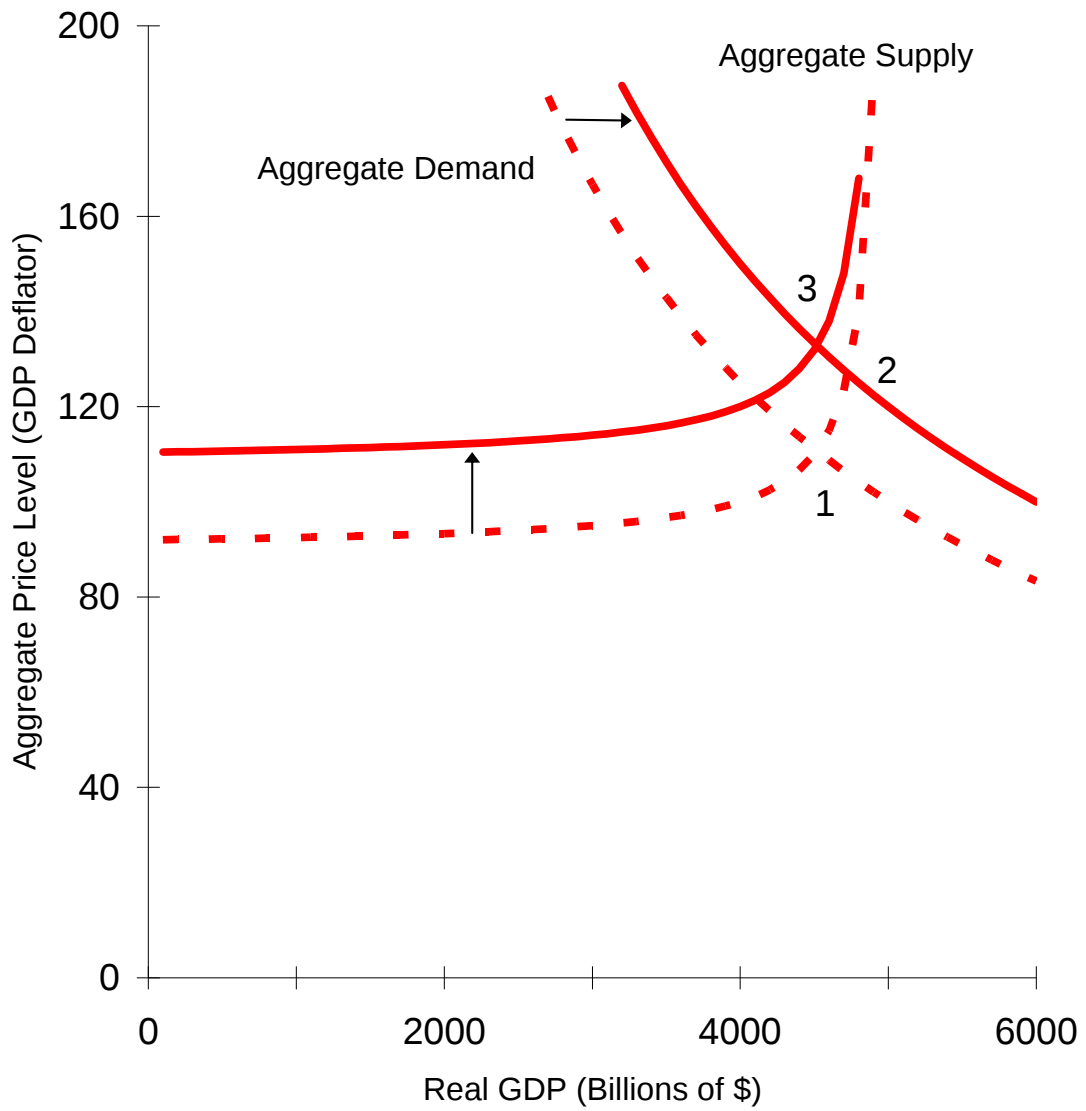
Meanwhile, the supply curve of labor also shifts upward, as seen in Figure 8.8. The wage that workers care about is the real wage, not the nominal wage that is measured by the vertical scale in Figure 8.8. The incentive to work when the wage is \$8 per hour depends on the cost of living. If the cost of living rises by 10%, then the nominal wage must rise to \$8.80 per hour to provide the same incentive that \$8 did before.

As workers recognize that prices of goods they buy have risen, the supply curve for labor shifts upward since the wage at which they are willing to supply a given quantity of labor will be higher. The effect will be to push wages up even higher and to reduce the quantity of labor that firms wish to employ.

When this process of upward adjustment in supply curves in individual markets, the aggregate economy, and the labor market is complete, the new equilibrium positions will be the points #3 in each of the figures. As the economy moved from point #1 to point #2 and then to point #3, it experienced a boom in output and employment with rising prices and wages, followed by a slump during which output and employment fell back to their original levels, but prices and wages rose even further.

In the end, the Fed's attempt to stimulate an economy that was already close to full capacity output and full employment only resulted in higher prices.

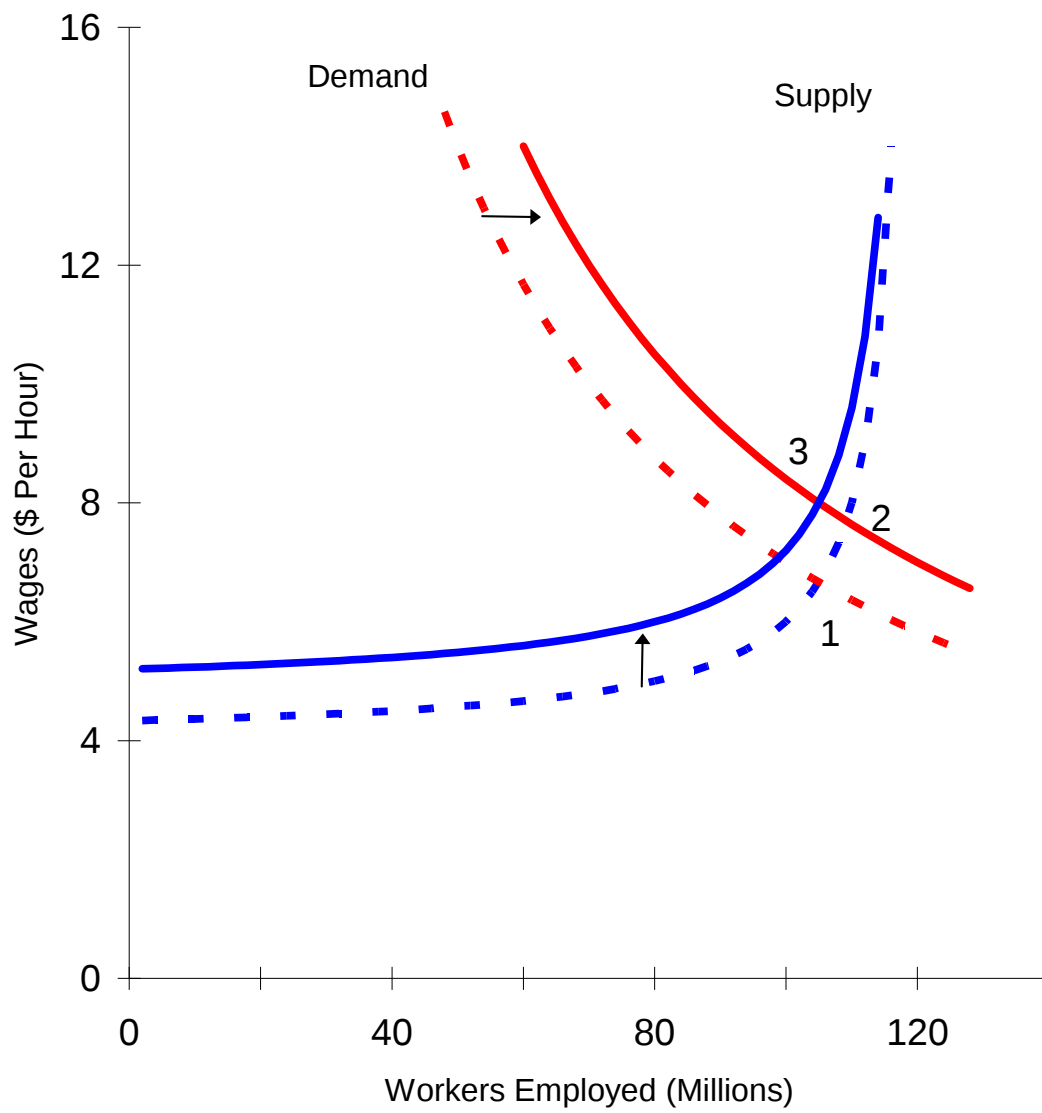
Figure 8.7: Aggregate Supply and Demand



This analysis, which is based on historical behavior of the economy during episodes of excessive monetary stimulus, is that there is a natural rate of output for the economy. Attempts by the Fed to stimulate the economy to operate above the natural rate sets off a process of price and wage increases that, when complete, leaves output back at its natural level following a temporary boom, and prices and wages permanently higher. Long term growth in the natural level of output does occur over time as the labor force grows and productivity increases, and these factors are reflected in the long term growth of real GDP which has averaged about 3% per year.

Since the natural rate of output corresponds to the highest sustainable level of employment in the economy, we say that the economy is then at full employment, even though the measured unemployment rate is higher than zero. The level of the unemployment rate which corresponds to the natural rate of output is called the natural rate of unemployment. The Fed can push the unemployment rate below this level temporarily, but only by setting off a burst of inflation.

Figure 8.8: The Labor Market



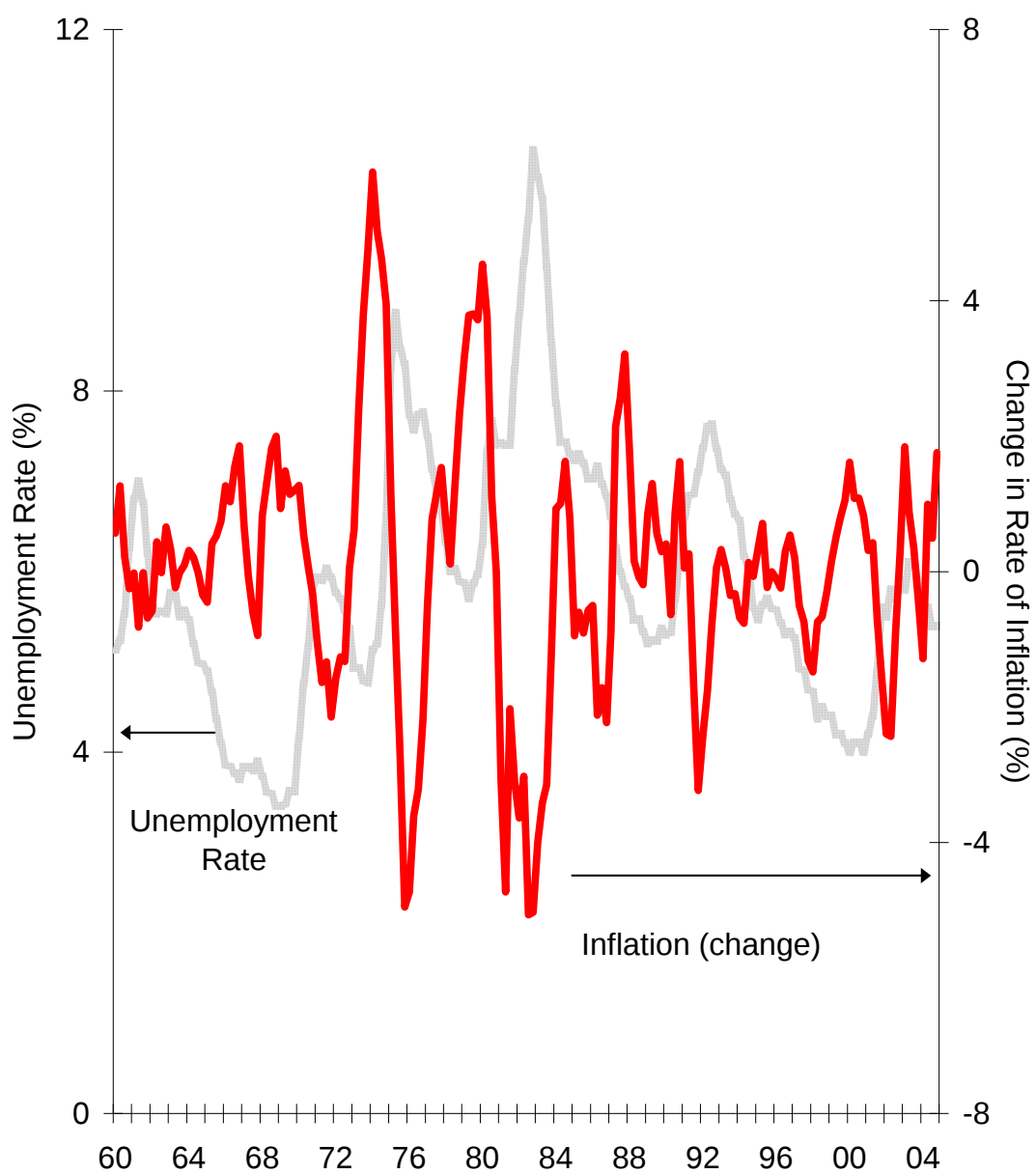
Can We See The Inflation Response in Actual Data?

The response of inflation to the level of unemployment in the U.S. economy is apparent in Figure 8.9. Notice that the rate of inflation tends to accelerate when the unemployment rate dips sharply. But we also see that there is no single trigger level for unemployment below which inflation inevitably jumps upward. For example, when the unemployment rate dipped below 5% in the 1960s, inflation accelerated. But in the 1970s, inflation accelerated when the unemployment rate only dipped below 6%. Most recently, the unemployment rate is well below 5% and so far there is no sign of significant inflation.

This suggests to economists that the natural rate of unemployment is not constant but changes slowly over time as demographics and other factors affect the labor market. Evidently, the natural rate of unemployment was higher in the 1970s than in the 1960s. Recall from our discussion of the unemployment rate in Chapter 5 that the 1970s was a decade during which an unusually large number of young workers, baby boomers, entered the labor force for the first time. Younger workers have higher rates of unemployment, on average, than do older, more experienced workers. As we moved from the 1970s through the 1980s and into the 1990s the ranks of new workers shrank, reflecting the birth-dearth that followed the baby-boom. Meanwhile, by the 1990s the baby boomers had matured into experienced workers with more stable employment. Labor economists estimated that the natural rate of unemployment had fallen to about 5%. So when the unemployment rate fell below that level in 1996 there was renewed concern about the danger of inflation. So far that has been a false alarm, and the unemployment rate is finishing the decade well below 5% without any sign of igniting inflation. This shows just how difficult it is to estimate the natural rate of unemployment in spite of all the data, computers, and statistical analysis we have today.

The decline in the natural rate of unemployment may be ending now, as the echo of the baby boom starts to pour out of the high schools and soon out of colleges to enter the labor force in large numbers.

**Figure 8.9: Inflation Accelerates When
The Unemployment Rate is Low**

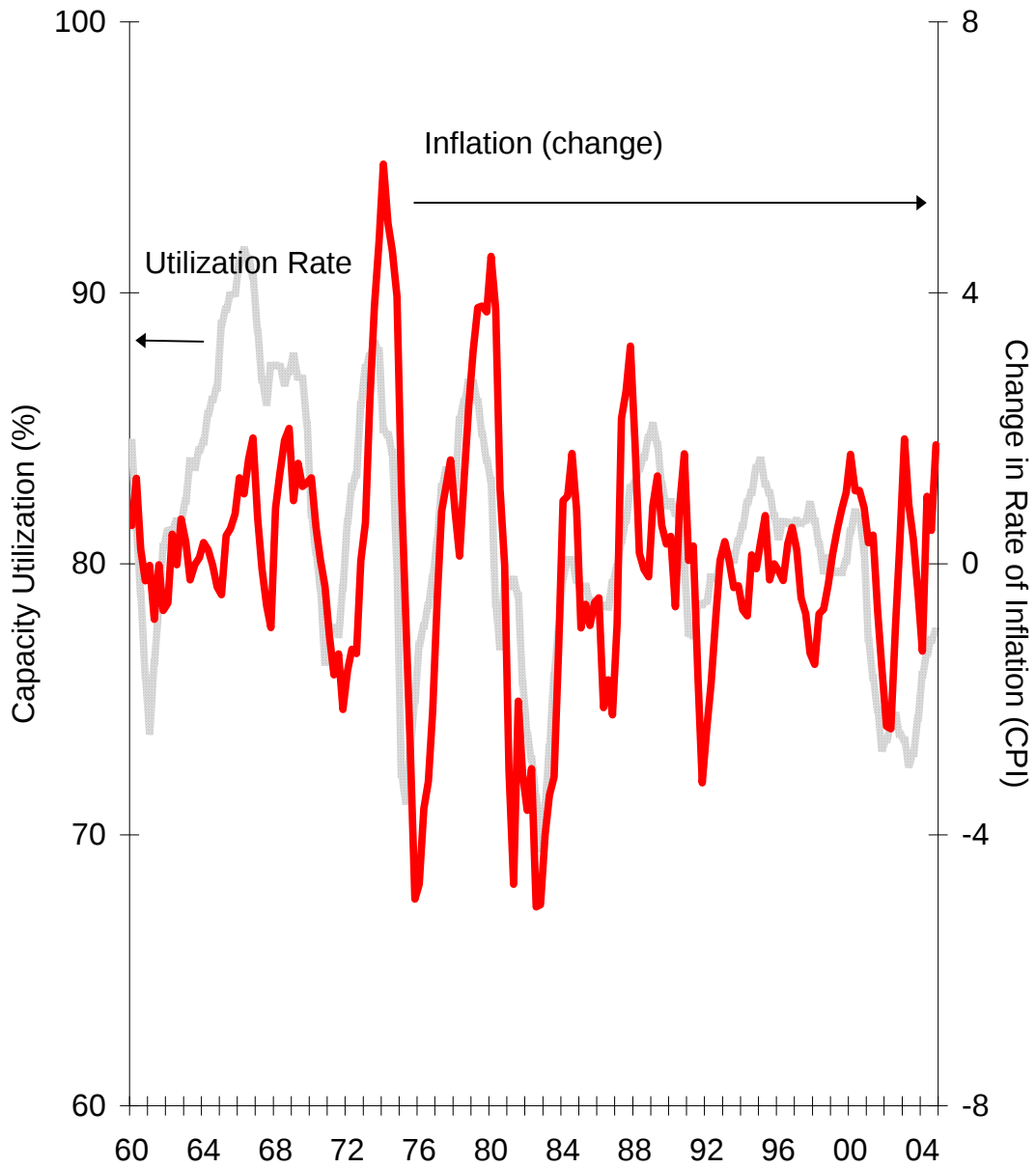


While we have no direct measure of the natural rate of output, the Federal Reserve Board does collect monthly data on the rate of capacity utilization in manufacturing. Firms are asked to compare their rate of output to a hypothetical "full capacity" rate, and the Fed compiles from these responses an index of capacity utilization that is expressed as a percentage. Our analysis suggests that as capacity utilization reaches higher levels, prices will tend to rise faster. Indeed, we see in Figure 8.10 that the Fed's index of capacity utilization does bear a positive relation to the change in inflation. When capacity utilization rises above about 80% inflation generally accelerates. Evidently, 80% corresponds roughly to the natural level of output.

But why isn't the natural level of output at 100% of capacity? Because, what industrial engineers mean by full capacity is the physical capability of their plant if operated without regard to cost control. What we are interested in as economists is the level at which prices and wages accelerate, and that corresponds to about 80% of physical capacity. Notice, too, that there is some lag between a rise in capacity utilization and the ensuing burst of inflation. The process by which wages and prices respond to changes in demand is not instantaneous but rather involves the period of adjustment that we have described.

When prices and wages continue to increase over a period of years, then we say that there is inflation. As you know, inflation has characterized the U.S. economy since 1960. We will discuss the dynamics of inflation in Chapter 9, using our understanding of price level adjustment developed in this chapter.

**Figure 8.10: Inflation Accelerates
When Capacity Utilization is High**



When Inflation Slows Down

We also observe that episodes of accelerating inflation are interspersed with periods of declining inflation, such as the early 1980s and the early 1990s. As we see in Figures 8.9 and 8.10, when unemployment is high or capacity utilization is low, then inflation slows down. At these times the process of adjustment of wages and prices we have described above goes into reverse. When workers are unemployed, employers find that they have plenty of job applicants and so do not need to raise wages as rapidly or at all. When firms have idle capacity they are willing to sell at lower prices than they would otherwise. Consumers find more "Sale" signs in store windows.

We can work through a hypothetical one-time decline in prices and wages by reversing the sequence of shifts in Figures 8.6 through 8.8. Here is how the sequence of events unfolds. First, the Fed boosts interest rates, causing demand curves for durables such as trucks to shift to the left. Output slumps and prices fall. The resulting decline in the demand for labor also causes wages to decline. That is not the end of the story because falling costs of production, including wages, cause supply curves to shift downward.

This downward shift is reinforced when workers recognize that the cost of living has fallen and so are willing to work at lower nominal wages than before. The economy moves, then, from an initial position at point #3 to the unnumbered intersection of the thin demand curve and the thick supply curve, and finally to point #1. During this transition the economy has experienced a temporary slump in output and employment, but returns to the natural levels of these variables with the only permanent effect being a fall in the price level and wages.

In actual practice, inflation has already been underway for some time when the Fed boosts interest rates, so the effect is not an immediate decline in prices and wages but rather a decline in the rate of inflation. But it is through this adjustment process that the Fed slows down inflation by slowing down the economy with a boost in interest rates.

Exercises 8.3

A. Discuss how the following changes in the economy would affect the natural rate of unemployment: 1) a large influx of untrained workers into the labor force, 2) the aging of the baby boom generation, 3) improved vocational training, 4) improved health standards.

B. Concern about renewed inflation was heightened in 1988 and 1989 before the recession of 1990-91 got under way. What factors in the economy might have lead to this concern? What happened as a result of the 1990-91 recession that dampened fears of inflation? Why had those fears returned by 1993?

C. In what way have the late 1990s have been a surprising time for macro-economists. What explanations have been put forward to account for the puzzling behavior seen in Figure 8.9?

8.4 The Quantity of Money Determines the Price Level

Our analysis and study of the data suggest that if the economy is at full employment when the Fed pushes interest rates down, the end result will only be an increase in the level of prices and wages. In that case there will be no permanent effect on real GDP or employment after the adjustment process is complete. Now we will argue that the resulting percentage increase in the price level is approximately equal to the percentage increase in the money supply, less the long-term growth rate of real GDP over the period of adjustment. How can we possibly know this?

It is implied by our model of the demand for money which says that the quantity of money demanded is proportional to nominal income at a given rate of interest. Consider this simple thought experiment:

Suppose that the economy starts the year with real GDP at its natural level. At the beginning of the year the actual supply of money was equal to demand so we start with the relationship

$$\begin{array}{rcl} \text{Supply} & = & \text{Demand} \\ M & = & k(i) \bullet P \bullet Q \end{array}$$

where P stands for the price level as measured by the GDP price deflator, Q is real GDP, $k(i)$ is a function of the interest rate I, and the symbol “ $\bullet$ ” means multiply.

The price deflator times real GDP is of course just nominal GDP, so this is the same money demand model we studied in Chapter 7. Let's use the symbols M, P, Q, and i to mean here the particular values of those variables at the beginning of the year. Suppose now that the Fed increases M by 10% at the beginning of the year to $1.1 \bullet M$. Further, it takes this imaginary economy a year to adjust to the effects of a money supply change and return to its natural level. This means that real GDP

will be $1.03 \bullet Q$ a year later, because the long-term growth rate of the economy is 3% per year. We cannot be sure what will happen to the interest rate, but let's assume for the time being that it will still be "i" a year later.

So far we have that one year later the quantity of money supplied by the Fed is $1.1 \bullet M$, real GDP has grown to $1.03 \bullet Q$, and i is unchanged. The only unknown variable is the price level P . This new price level can be expressed as $X \bullet P$, where "X" is the unknown factor we want to solve for. Setting the supply of money equal to demand one year later, we have

$$\text{Supply} = \text{Demand}$$

$$1.1 \bullet M = (X \bullet P) \bullet (1.03 \bullet Q) \bullet k(i)$$

How much of an increase in P is required to equate the increased money supply with demand? Divide both sides of the equation by M , using the fact that $M = P \bullet Q \bullet k(i)$. This leaves

$$1.1 = X \bullet 1.03$$

so the factor X is about 1.07, since $X = 1.1/1.03 = 1.07$, approximately.

In words, the equation tells us that a 10% increase in the supply of money leads to a 7% increase in the price level. That is because 7%, along with the normal 3% growth in real GDP, just enough to cause 10% more money to be demanded in the economy. Thus, the balance between money demand and money supply has been restored at the natural rate of output.

The shifts in the money supply and demand curves that correspond to these two equations are illustrated in Figure 8.11. The initial quantity of money supplied by the Fed is set at \$600 billion, indicated by the thin line. The initial demand for money is the thin curve which intersects the supply line at point #1 where the interest rate is 5%. When the Fed increases the supply of money by 10% to \$660 billion, indicated by the thick line, the new intersection with the demand curve is at point #2 where the interest rate is only 4.5%. This rate is low enough that people are willing to hold 10% more money.

That drop in the interest rate sets in motion the process we studied in Section 8.3: higher investment spending, greater aggregate demand, greater demand for labor, and then higher prices and wages causing an upward shift in aggregate supply.

As prices and wages continue to rise, the demand for money curve shifts rightward because the quantity of money demanded at any given interest rate increases in proportion to the price level. When the amount of that rightward shift has reached 10%, then the demand and supply curves intersect again at the original level of the interest rate which is

labeled point #3. An increase of 7% in prices, combined with an increase of 3% in real GDP over the one-year adjustment period, is enough to do it.

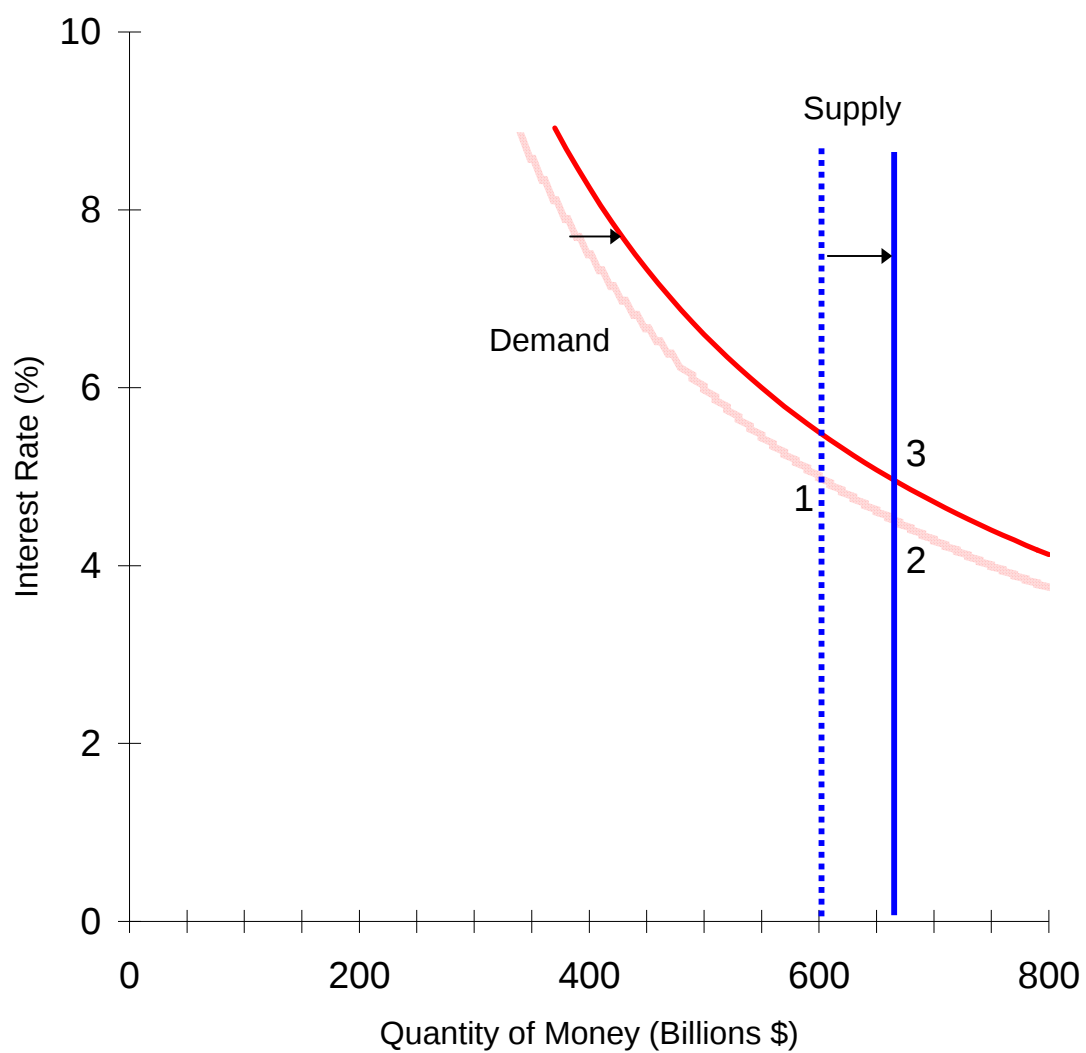
Now that the interest rate is back at its original level of 5%, the adjustment process is complete. The interest rate will stay at 5% until something else happens that shifts either the supply of money or the demand for money. But, how do we know that?

Recall that the economy moved initially because an increase in the money supply had reduced the interest rate, stimulating demand for consumer and business durable goods, resulting in increased aggregate demand at the original price level. This led to a temporary rapid increase in real GDP and the price level was rising. The process of adjustment to the new and higher price level was complete when real GDP had fallen back to its natural level because then there is no further upward pressure on prices and wages.

At the new higher price level, the demand for money is equal to the new higher supply at the old level of interest rates. With interest rates back at their old level, the demand for durable goods is also back to its original level. That is why real GDP is also back at its natural rate. Of course, the natural rate of GDP has continued to grow at its usual 3% per year during this adjustment.

In the end, the change in the money supply has only determined the level of prices.

Figure 8.11: The Transition to a Higher Price Level



The Quantity Theory of Money

The idea that the price level is determined by the quantity of money is called the quantity theory of money. It is a very old idea in economics, having been clearly articulated by the English economist and philosopher David Hume in his essay "On Money" published in 1734. Hume observed that the large quantity of gold brought to Europe from the New World by the Spanish had been followed by a proportionate increase in the price level. In Hume's day, money was based on a gold standard. But does the quantity theory of money still work in our economy today?

The quantity theory says that the change in the price level can be predicted from the change in the quantity of money if we adjust for long term real growth in real GDP. From 1960 to 1999 the quantity of M1 increased by a factor of 7.9 while real GDP increased by only a factor of 3.5. The quantity theory of money clearly implies that there should have been a large increase in the level of prices. Certainly there has been considerable inflation in the U.S. economy during those forty years, but how close does the quantity theory of money come to predicting the right amount? It predicts that the GDP deflator price index should have increased by a factor of $7.9/3.5 = 2.3$ over the same period, more than doubling. In fact, we experienced even more inflation than that. The price level actually increased by a factor of 4.9. So the theory explains about half of the increase in the price level over this period, and the actual increase was even more than predicted.

What is the explanation for this difference? First, we have the fact that interest rates are higher than they were in 1960. Recall that $k(i)$ is the demand for money per dollar of nominal GDP as a function of the interest cost of holding money. Higher interest rates mean that holding money is more expensive $k(i)$ is smaller as people economize on their holding of money. The ratio of M1 to GDP did decline from .27 in 1960 to .12 in 1999, while the Treasury bond yield rose from 4% in 1960 to over 6% in 1999. Now look again at the equation " $M = k(i) \circ P \circ Q$." With M and Q given, and $k(i)$ lower than it was in 1960, it must be that P is even higher than it would have been if interest rates had remained constant.

A second part of the explanation is that $k(i)$ has fallen even more due to changes in how we use money that make it easier for people to economize on the use of cash. The proliferation of ATMs and credit cards are the most visible examples, but electronic transfer of funds has also had a major impact in reducing the amount of M1 that we need to do business.

The margin of error in the quantity theory of money can be traced, then, to its simplifying assumption that $k(i)$ remains constant. The quantity theory of money can be thought of as an approximation that explains the direction and rough magnitude of the change in the price level over long periods of time. Experience over many historical periods and many countries has demonstrated its usefulness. What is the lesson?

The quantity theory of money implies that when a country increases its money supply faster than the long term growth rate of real GDP, it will almost surely experience inflation. And the change in the price level will be approximately the difference between the growth of money and the growth of real GDP.

Exercises 8.4

A. Suppose that in 1997 the unemployment rate in the U.S. is 4.9% and the yield on T bills is 4%. A new Fed Chairperson urges the FOMC to order open market operations that will result in an immediate 20% increase in the quantity of M1. By doing this, the new Chair hopes to push the unemployment rate down to near zero. At the time you are working as assistant to the president of manufacturing firm, and she asks you to prepare a forecast for the economy taking account of the Fed's new monetary policy. Use the analytical framework of this chapter to sketch a forecast of interest rates, the price index, and real GDP. Use graphs to illustrate the sequence of events.

B. Imagine that you have been appointed Chair of the Federal Reserve, and you would like to conduct monetary policy in way that will keep interest rates at their present levels without a large increase or decrease. Assume that unemployment is at 5%, inflation is at 2%, and the Treasury bill yield is 4%. What should be the rate of change in the supply of money per year in order to accomplish your objective?

C. During 1993, Russia experienced rapid inflation while her central bank printed new money at a furious pace. The head of Russia's central bank was quoted in the press as claiming that there was no connection between inflation and the fact that the central bank was printing money rapidly. Use the framework of money demand and the natural rate of output to explain why there is most likely a strong connection between these two phenomena.

D. Using the data given above, what can you say about how the velocity of M1 has changed since 1960? Is that change consistent with what has happened to variables that affect velocity?

8.5 The Growth Rate of Money Determines the Rate of Inflation

So far in this chapter we have analyzed the response of the economy to an increase in the supply of money. To recap briefly, the interest rate initially falls since people are willing to hold a greater quantity of money only if it is cheaper to do so. The lower cost of borrowing then stimulates the demand for durable goods, including new plant and equipment and consumer durables. As firms respond to increased demand, output and employment rise and the unemployment rate falls. But prices also rise in

response to the increased demand for goods and wages rise in response to strong demand for labor. Rising labor costs further reinforce the upward adjustment in the price level. As the price level rises, the demand for money increases, pushing the interest rate back up. With the cost of borrowing rising, the demand for goods subsides and real GDP moves back toward its "natural" level.

This adjustment process is complete when the price level has risen by just enough so that the demand for money equals the increased supply of money at the original rate of interest. The price level will rise by the same percentage as did the supply of money, after subtracting 3% per year for normal growth in real GDP.

In this final section we want to analyze how the economy will respond to a *continuing* increase in the supply of money, and to changes in that rate of increase in the supply of money.

For example, suppose that it is the policy of the Fed to increase the supply of money at a rate of 5% per year, year after year. What will be the rate of inflation? The rate of interest? The level of unemployment? If the Fed alters its monetary policy so that the growth rate of the money supply jumps to 10%, how will real GDP, unemployment, inflation, and interest rates be affected?

To answer these questions we need a *dynamic* version of the demand for money model. We will then use the model to link rates of change in the money supply, the price level, the interest rate, and real GDP. Recall that by setting the supply of money equal to the demand we found:

$$\frac{\text{Supply}}{M} = \frac{\text{Demand}}{k(i) \cdot P \cdot Q}$$

Reviewing briefly, this equation says that the supply of money set by the Fed, M , is equal to the demand for money, and that the demand for money is proportional to the price level, P , times real GDP, Q . That factor of proportionality, called $k(i)$, can be interpreted as the amount of money demanded per dollar of income because the equation can be rearranged as $k(i) = M/(P \cdot Q)$ and $(P \cdot Q)$ is just nominal GDP. Further, $k(i)$ varies inversely with the interest rate, i , since people wish to hold less money when the opportunity cost of holding money (instead of bonds) is high. In Chapter 7 we saw that this very simple model provided a reasonable approximation to the actual relationship that we observe in the U.S. economy between the ratio of nominal GDP to $M1$ and the interest rate.

Putting the Money Demand Model "Into Motion..."

Now we convert this equation into a relationship between the rates of change in these variables by using the familiar algebraic fact that the percent change in the product of two variables is approximately the sum of the percentage changes in each. Recall that if $Y = X \cdot Z$, then the percent change in Y is approximately the percent change in X plus the

percent change in Z, and the approximation is better for small changes. The model therefore implies that the percentage change in money is approximately equal to the percentage change in $k(i)$, plus the percentage change in the price level, plus the percentage change in real GDP, which we can express in equation form as

$$\mathbf{M\% = k(i)\% + Q\% + P\%}$$

where "%" means the percentage annual rate of change in the variable it follows, and "_" means "approximately equal to." The degree of error in the approximation is small enough that we can ignore it for our purposes, since rates of change are relatively small in the US economy. Consequently, we replace "approximately equal" with "equal" and write our model as:

$$M\% = k(i)\% + Q\% + P\%$$

What does this equation tell us about the inflation rate if the Fed continues to increase the money supply at a rate of 10% over a long period of time, say several years? Since we want to predict $P\%$, let's put it on the left hand side of the equal sign and all the other variables on the right, so we have:

$$\mathbf{P\% = M\% - k(i)\% - Q\%}$$

This result says that the inflation rate will be equal to the rate of change of money, minus the rate of change of $k(i)$, minus the growth rate of real GDP. Notice that the growth rate of real GDP, $Q\%$, is subtracted from the growth rate of money to get the rate of inflation. Evidently, real growth in the economy exerts a negative influence on inflation. This makes sense because the growth of real GDP is a source of growth in the demand for money, since the physical volume of transactions that need to be settled with money is growing. That growth uses up $Q\%$ of the $M\%$ growth in money, leaving the remaining $(M\%-Q\%)$ to fuel inflation.

To calculate the value of $P\%$ using this equation we need to have values for the rate of change $k(i)\%$ and $Q\%$. Taking $Q\%$ first, we recall that the growth rate of real GDP is limited over any long period of time to the long term growth rate of the full employment or natural level of GDP which is about 3% per year. Thus, the rate of inflation over a period of several years will be approximately

$$P\% = M\% - k(i)\% - 3\%.$$

Now what can we assume about the value of $k(i)\%$, the rate of change of the demand for money per dollar of income, over a long period? Since in our simple model $k(i)$ depends only on the interest rate, this is

equivalent to asking: What we can assume about the behavior of the interest rate over a long period? Let's conjecture that if the money supply is growing at a constant rate, then the interest rate will find a level at which it will be stable, so that the function $k(i)$ of the interest rate will also be stable. (If a variable does not change, then a function of that variable does not change.) This means that we can set $k(i)\%$ at zero in our equation for $P\%$. Whether this conjecture is reasonable will become apparent when we finish our solution to the model.

For our example of a continuing 10% growth rate of money, then, the equation predicts that the inflation rate $P\%$ will be:

$$P\% = 10\% - 0\% - 3\% = 7\%.$$

Does this equation make sense from what we understand about the demand for money? It says that inflation at a rate of 7% will be the result of a policy by the Fed of increasing the supply of money at a rate of 10% per year over a long period. The rate of growth in the demand for money (7% due to inflation plus 3% due to long term growth in real GDP) just balances the 10% growth in the supply of money. Therefore, since money demand and money supply remain in balance in this scenario, there is no pressure on the interest rate to move either up or down. Thus, the amount of money demanded per dollar of income remains constant. Now it is clear that our conjecture that we could set $k(i)\%$ at zero is consistent with the solution to the model which it implied. This is a good example of a general strategy for solving models in economics and other fields: use your intuition to conjecture some key features of the solution and then use them to obtain the complete solution, finally showing that the resulting solution is internally consistent.

What Will the Interest Rate Be?

What stable value of the interest rate is consistent with an inflation rate of 7%? If the economy is to be operating at its natural level of employment, with real GDP growing at its long term rate of 3%, then the real rate of interest must be at its long run average level. If the real rate of interest were lower than that, then the economy would be booming and employment and real GDP would be above their natural levels, causing, in turn, a further increase in inflation. If the real rate of interest were above its long run average level, then the economy would be in a recession, with high unemployment and falling inflation. The economy being at its natural level of employment requires that the real rate of interest also be at its "natural" level, where the demand for durable goods is consistent with normal long run growth in real GDP, not unusually high nor unusually low. We therefore take the long run average of the real rate of interest as our measure of its natural level.

Recall that in Chapter 4 we saw that the real rate of interest for Treasury bills, the nominal interest rate minus the CPI inflation rate, has

averaged about 2%. Also, the nominal interest rate, i , is related to inflation and the real rate, r , by the definition:

$$i = P\% + r$$

This means that we can expect that over a long period of time that i will be approximately $P\% + 2\%$, thus

$$i = P\% + 2\%.$$

In our example, where the inflation rate is 7%, we would expect the T bill yield therefore to be about 9%.

What we have now is the full solution to our model of inflation for a situation in which the money supply grows at a constant rate of 10% per year. The rate of inflation will be about 7% and the rate of interest about 9%. Since the growth rates of all the variables turn out to be constant, this type of situation is called a **steady state**.

A Simple Lesson About Inflation

When the growth rate of the money supply exceeds the long term growth rate of real GDP, it will eventually result in inflation approximately equal to the difference. Further, the nominal rate of interest will reflect the rate of inflation, tending to be approximately the rate of inflation plus a relatively stable real rate of interest.

How useful is this conclusion for understanding economies in the real world? After all, we never really see a central bank increasing the money supply at a constant rate indefinitely. Haven't we just gone through a thought experiment that is unrelated to real experience? No, not really.

The properties of the steady state are very useful for comparing economies where there is a large difference between the average money growth rates. For example, in Switzerland the growth rate of money has averaged only slightly more than the long term growth rate of real GDP. You can be confident that the inflation rate there is only a percent or two, and interest rates are only a bit more, perhaps 3% or 4%. But if you had visited Russia in the 1990s, when the central bank helped to finance government spending by printing money, you would have found that the inflation rate was very high, with interest rates at similarly stratospheric levels. An implication of our understanding of the steady state is this: If Russia were politically able to stop printing of money (requiring better tax collection to finance government spending), then it would enjoy lower inflation and lower interest rates. In fact, that prediction of the theory was born out by the reforms in Russia during the past decade – rapid inflation is a thing of the past.

Exercises 8.5

A. Give a forecast of inflation and the Treasury bill yield in the case that the Fed keeps the money supply growing at a steady rate of 4%.

B. Country X has a persistent inflation rate averaging about 25% per year while country Y has little inflation. What would you expect to find if you compared the rates of growth of the money supply in the two countries? interest rates? the demand for money per dollar of income? the velocity of money?

END