A STICKY WAGE MODEL

Before we can address some important aspects of policy, we need to consider an alternative view of how changes in aggregate demand affect the economy. Many economists hold this alternative view since they doubt that higher interest rates generate much additional work effort, and for practical purposes take the $Y^e$ curve to be vertical. For changes in the production function this belief does not change the results of the model very much. For a technological improvement there is no change in the analysis at all. The $Y^e$ curve still shifts out by the same amount as the $Y^d$ curve, there is no change in the interest rate, and output increases. For a temporary shock to the production function, such as a temporary increase in the price of oil, the $Y^e$ curve still shifts back and to the left. Output declines and the interest rate rises.

An important difference in the results does occur for changes in investment demand and temporary changes in government spending. Both of these changes shift the $Y^d$ curve, and are often called demand shocks. If the $Y^e$ curve is vertical, these demand shocks have no effect on real output. They only cause the interest rate to rise. Many economists believe that demand shocks are important for understanding short-run movements in real output, and a vertical $Y^e$ curve implies the opposite.

Another potential shortcoming of the real business cycle model has to do with the short-run effects of a change in the money supply. In the basic model, money is neutral and most economists agree with this result for the long run. If the money supply doubled today, 30 years from now the only remnant of the doubling would be a higher price level, roughly double what it would otherwise have been. However, in the short run many believe that a change in the money supply affects real output. For example, David and Christina Romer argue that the Fed embarked on an anti-inflation, and thus an aggregated demand reduction, program prior to each
of the post-war recessions. Moreover, for monetary policy to have important real effects on the economy, money must not be neutral, at least in the short run.

The models we have studied so far assume that prices adjust rapidly and smoothly. For example, our story goes that an increase in the money supply generates increased dollar spending, the higher dollar spending leads producers to raise prices and to raise wages to attract more workers. Wages and prices rise by the same proportion, so real wages stay the same, and there is no change in real output, work effort, or the interest rate. Many economists believe that this adjustment takes considerable time because in the short run wages and prices are sticky. Wages may be sticky and slow to adjust for two reasons. Wage contracts may lock in nominal wages in the short run, or workers may fail to demand higher wages because they lack information on the extent of the price increase. If either of these cases holds, an increase in demand calls forth greater output as the gradual adjustment takes place.

In the next section we explain the implications of the two sources of wage stickiness, and derive a new aggregate supply curve with the supply of output now plotted against the price level. We then relate aggregate demand to the price level. We next turn to the effects of demand shocks and changes in the money supply in the sticky wage model, and compare them to demand shocks in the real business cycle model. Criticisms of the sticky wage approach are then discussed. We also consider two extensions that are important in the historical development of macroeconomics: the Phillips curve and the notion of demand determined output.

The Aggregate Supply Curve

To keep matters separate, when we introduce sticky wages we assume that there is no effect on the supply of output from a change in the interest rate. Also, in the long run prices and wages remain flexible and fully adjust in the way described by the real business cycle model. In particular, in the long run there is no relationship between the price level and real output. Instead, output settles down at the same level as predicted by the earlier model. This means that the long run aggregate supply curve, the LAS, plotted against the price level is vertical as shown in Figure 23.1. So, if the money supply doubles, in the long run output will return to its long run level, 25,000 units in the figure, but prices would double to 240.

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There are two traditional causes of sticky or slow-to-adjust wages. One potential cause stems from the fact that some nominal wages are fixed by contracts, legal agreements between the employer and the employee that fix the dollar wage over some period of time. A second, more subtle, reason is imperfect information. If workers are not aware of the increase in the price level, but firms are, then the full adjustment of the nominal wage to a change in prices will not occur rapidly. Instead, it occurs over time as workers come to realize the magnitude of the price change. We examine each of these rationales in turn.

a. nominal wage contracts

Many workers in the economy agree to wage contracts with their employers. The typical illustration of wage contracts is union wage contracts. Union representatives enter into collective bargaining agreements with management. In the U.S. these agreements typically last three years. In any given year, some unions will be negotiating new contracts while others will be in the first or second year of theirs. Because of this, union contracts are said to overlap. For now let us think of union wages as being set in nominal terms. This means that the first year wage is some number of dollars, and next year's raise is specified in terms of dollars also, and so forth. There will be an important qualification to this assumption later.

We now look to see how overlapping nominal wage contracts may lead to a positive relationship between the price level and the supply of output. Suppose the price level initially equals 120, and then increases to 126 as in Figure 23.2. In the absence of wage contracts workers would demand higher wages, and all wages would change in proportion to the change in the price level. The real wage would be maintained, and equilibrium in the labor market would go undisturbed.
However, this will not happen if nominal wages are sticky because some contracts are not up for renegotiation. Since some workers are locked into their nominal wage, there will be some firms that will not have to raise their wages. These firms can sell their goods for a higher price, but do not have to pay their workers a higher wage. Firms in this position will want to hire more workers to increase their output. As they hire more workers employment and output rise. In Figure 23.2 the increase in the price level from 120 to 126 increases output from 20,000 units to 20,500.

It is important to note that this argument requires the change in the price level to be unexpected. Otherwise negotiators would have factored the effect of the price increase into their wage demands. For example, suppose union negotiators had expected prices to increase by 5% to raise the price level to 126. In this case, they would have revised their wage demands upward by the same 5% to insulate the workers from the effect of higher prices.

There remains an open question. The above story only says that some firms want to hire more workers, but where do these new workers come from? In order for the above story to work, there must be an initial surplus of workers in the economy, and where does this surplus come from?

One possible source of a surplus of workers are high relative wages. To see this, suppose that there is two sectors in the economy: the high wage union sector paying $20/hr and a low wage competitive sector paying $4/hr. There may be many people in the economy who would be willing to work for $20/hr. Indeed there may be more people willing to work at $20/hr, than there are union jobs. Suppose that the supply of labor at $20/hr is 500 workers, but that there are only 100 union jobs. There will be 400 unhappy workers. Some of these workers will, reluctantly, take jobs in the competitive sector, but there will be some who choose leisure or home production over the low competitive wage. Suppose of the remaining 400 workers 150 chose to work in the competitive sector while 250 enjoy leisure or work at
home. These 250 workers form the surplus who are ready to take the high paying jobs when they come open.

Will this increase in output persist? The answer is no. When the wage contracts come up for renegotiation, the union will demand a higher nominal wage for their members in order to restore their original real wage. The positive relationship between the price level and the supply of output is only temporary. As the contracts are renegotiated, output returns to its long run level.

b. imperfect information

A second rationale for a short run positive relationship between the price level and the supply of output relies on the notion that households may not know the price level all of the time. Households are not specialists in the acquisition of information, and cannot keep track of every price change. As shoppers we may be able to keep track of the prices of goods that we buy each week, but many goods are not purchased weekly or even monthly. For example, you're unlikely to follow the prices of new refrigerators unless yours is on the blink. There are just too many goods and too little time to keep up with all the prices.

Firms, on the other hand, are specialists in acquiring information, and presumably keep up with the prices of competing goods, and the prices of the inputs that they use. So, firms have complete information about prices when they make their decisions, but households do not.

How does imperfect information lead to the positive relationship between the price level and the supply of output? To begin, consider a simple numerical illustration. Suppose that initially all parties, both firms and households, know all prices, and the price level is $100. Assume that the nominal wage is $400 per period. This makes the real wage 4 bundles per period. Now suppose that there is an increase in the price level of 5% so that the price level increases to $105. For the
sake of clarity, make the extreme assumption that none of this price increase is perceived by households. They still think the price level is $100.

The firm wants to raise output to take advantage of the price rise, but to do this they must attract more workers. In an effort to attract more workers they increase the nominal wage offer by 2 1/2% so that dollar wages are now $410 per period. Though the nominal wage has risen, real wages have fallen to $410/$105 = 3.90 bundles per period. Here is where the ignorance of the household comes into play. Since households still think that the price level is $100, they interpret the increase in the nominal wage as an increase in their real wage. In our example households believe their real wage has risen to 4.1 bundles = $410/$100. This perceived increase in their real wage induces an increase in the quantity of labor supplied, and is the source of the new hires by firms. This situation in the labor market is shown in Figure 23.3. The higher price level thus leads to an increase in work effort and with this additional work effort more output is produced, increasing from 20,000 to 20,250 units in Figure 23.4.

This increase in output is not permanent. At some point households will learn the new price level, and realize that their real wage is lower than they had thought. When this occurs the increase in employment and output unravel, and the economy returns to its initial position of long run equilibrium with a real wage of 4 bundles per period. So, just as in the case of nominal wage contracts, the positive relationship between the price level and the supply of output occurs only in the short run. Also, it is important to notice that for the argument to work the price rise must again be unexpected since informed households would recognize the higher price level and would not supply more work effort to the market.

The Aggregate Demand Curve
The economics of the aggregate demand curve are no different in this model than in the real business cycle model. There appears to be a basic agreement among economists on the fundamentals of consumption and investment demand. The only difference here is that aggregate demand is plotted against the price level instead of the interest rate. Let us take a look at this relationship.

We first describe the intuition. Suppose the price level falls from, say, 115 to 110. This is shown in Figure 23.5. The decrease in the price level increases the supply of real money balances, $M^\prime/P$ rises. With this initial excess supply, people buy bonds. The increased demand for bonds raises bond prices, and lowers the interest rate. The lower interest rate then generates an increase in both consumption and investment demand, just as usual, increasing aggregate demand from 19,500 units to 20,000 in Figure 23.5. So, the higher price level induces lower interest rates, and this increases aggregate spending.

You may have noted that the initial excess supply of real money balances could have been spent directly on goods. This is entirely possible, and such an effect is called a real balance effect. Taking this possibility into account does not change the message of the story; it only reinforces it. The key insight from Figure 23.5 is that a lower price level increases desired spending.

We can follow the above argument in more detail in Figure 23.6. In the northwest panel the demand for real money balances is plotted against the interest rate, and our usual $Y^d$ curve is reproduced in the northeast panel. At the price level 180, and with a nominal supply of money of $400, the supply of real money balances is 400/180. An interest rate of 6% clears the money market, and at an interest rate of 6% aggregate demand is 20,000 units. The combination 180 and 20,000 is plotted in the southeast panel. Now suppose the price level falls to 170. This increases the supply of real money balances to 400/170, and induces a fall in the interest rate to
5%. The lower interest rate leads to an increase in the amount of goods demanded to, say, 21,000 units, and gives the second point in Figure 23.6. The two points yield the aggregate demand curve, AD, and tell us that this curve slopes downward.

Along any given AD curve the price level, aggregate demand itself, and the interest rate vary. The demand shock variables, government spending and the profitability of investment projects, are held constant along an AD curve as are the nominal supply of money and transactions costs. We need to know how the AD curve shifts when each of these variables changes.

Look at the initial AD curve in Figure 23.7. At the price level 115, aggregate demand is 19,500 units. Now suppose there is a temporary increase in government spending of, say, 1,500 units, financed by an increase in lump sum taxes. The G in aggregate demand increases, and, since the lump sum tax increase used to finance it is temporary, there is no decline in consumption. At the price level 115, households, firms, and the government now demand more goods, 21,000 units. This means that the AD curve shifts out and to the right in
response to a temporary increase in government spending, and we say that aggregate demand has increased.

The effect of an increase in the profitability of investment projects is similar. When the profitability of projects increases, firms demand more goods so they can undertake more projects. If we began again at a price level of 115, more goods will be demanded at this price level; and the AD curve again shifts out and to the right, just as in Figure 23.7. Both a temporary increase in government spending and an increase in investment demand increase aggregate demand.

An increase in the nominal supply of money, $M^*$, also shifts the AD curve out and to the right. For a given price level an increase in the nominal supply of money causes an initial excess supply of real money balances. Households use the excess supply to buy bonds, bond prices rise, and the interest rate falls. The lower interest rate causes an increase in consumption and investment demand, so aggregate demand increases moving the AD curve out and to the right. Since the AD curve shifts in the same way as it does from an increase in investment demand or a temporary increase in government spending, many refer to changes in the nominal supply of money as a demand shock.

You may have noticed that the argument here is very similar to the one we gave to justify the downward sloping AD curve because both rely on an increase in the supply of real money balances. The difference arises from the source of the increase in $M^*/P$. In the present case, an increase in the nominal supply of money, $M^*$, caused the increase in $M^*/P$, whereas in the earlier case a decrease in $P$ caused real money balances to rise.

Finally, an increase in transactions costs increases money demand. To satisfy this increase in money demand households sell bonds, and bond prices fall. This produces an increase in the interest rate, and a decline in aggregate demand. So, an increase in $\gamma$ shifts the AD curve down and to the left.
The AD-AS Model

Figure 23.8 shows an initial equilibrium in the AD-AS model. The price level is \( P^* \) and output is \( Y^* \), and for simplicity we let \( Y^* \) equal the long run equilibrium level of output. To see if there are forces at work that drive the economy toward its equilibrium consider the price level \( P^h \). At \( P^h \) there is an excess supply of goods. Producers fail to sell all they produce, and in the face of this failure they lower prices and cut back production. As the price level declines the supply of real money balances increases, and the interest rate falls, causing an increase in aggregate demand. The economy moves along the AD curve toward equilibrium. This continues until the gap between the aggregate of goods demanded and supplied closes. A similar argument holds if the price level is initially too low, so there are forces at work that drive the economy towards equilibrium.

Now suppose there is a demand shock, say from a temporary increase in government spending. The AD curve shifts out and to the right to \( AD' \). At the initial price level in Figure 23.9, there is an excess demand for goods, so firms see an increase in spending on their products. This, in turn, leads them to charge higher prices, and the economy begins to move up the AS curve. The higher prices result in greater employment and output because of nominal wage contracts, imperfect information on the part of workers, or some combination of the two. In the short run, the economy moves to a higher price level, \( P^{**} \), and a higher level of output, \( Y^{**} \).

The source of the demand shock does not matter here. It could have arisen from an increase in investment demand, and the analysis would have been the same. The AD curve shifts out and to the right, and output and the price level both increase.
An increase in the nominal supply of money also shifts the AD curve out and to the right increasing output and the price level. This means that money is not neutral in the short run. In particular, an increase in the money supply causes lower real interest rates, more work effort, and higher output. We conclude that in the sticky wage model demand shocks, whatever their source, affect real output even if there is no interest rate effect on the supply of output. These results set the sticky wage model apart from the real business cycle model.

Why Does Neutrality Fail?

Though the nominal wage contract and imperfect information stories are independent of each other, the driving force behind them is the same. In both scenarios, neutrality fails because people must base their actions on expectations of the price level, and when these expectations go wrong, real behavior changes. In one case, expectations go awry because it is costly to acquire information. In the other case, contracts are frustrated because parties lock into nominal wages before the price level is known.

This means that only unexpected changes in the money supply will affect output. In the imperfect information model, if you know the money supply has increased, you are alerted to the possibility of price increases; and will be harder to trick. In the contracts model, if you anticipate an increase in the money supply next year, and hence an increase in the price level as well, this expectation can be figured into your wage demands. You bargain for a higher nominal wage next year to protect your real wage from the price increase.

An unexpected increase in the money supply increases output, but it is not at all clear that this makes the people in the economy happy. In the imperfect information case, people do things that they wouldn't do if they were better informed. In short, they will not be happy about being tricked into working harder. In the nominal wage contracts case the current workers will be upset when they find their real wage below the level for which they had bargained. This has important implications later in our discussion of monetary policy.

Criticisms of the Sticky Wage Model
The key feature of the sticky wage model is the upward sloping AS curve. Critics of these models argue that the rationales for such an AS curve are not persuasive. The criticisms of the nominal contract approach are somewhat different than the criticisms of the imperfect information approach so we take each in turn.

a. criticisms of the nominal wage contract rationale

There are several weak points in the nominal contracts argument. First, wage contacts often have cost of living adjustments (COLAs) in them. A perfect COLA would automatically cause nominal wages to increase by the same proportion as the change in the price level. The increase in the nominal wage caused by the indexation would exactly offset the increase in prices and eliminate the incentive of firms to hire more workers. However, COLAs are not perfect. They occur with a lag so that workers are compensated this year for price increases that occurred last year. Also, COLAs are often partial, only adjusting for some fraction of the price increase. For example if indexation were 70%, then an increase in prices by 10% raises nominal wages by only 7%. The existence of COLAs does not eliminate the possibility of a positively sloped AS curve from wage contracts because the indexation is not perfect. However, it does weaken the contracts argument, and suggests that its empirical importance may be limited.

Will the employed union workers, or any workers for that matter, be happy with employers who let their real wages fall? The answer is, of course, no. Moreover, in industries where contracts are important the relationship between firms and their workers tends to be long term. Workers, directly or through their unions, have an incentive to protect themselves from undesired and unexpected changes in their real income. A firm that continually exploits an increase in the price level encourages its workers to demand higher real wages. To avoid these demands, firms may maintain a good relationship with their workforce by protecting their real wages from shocks to the price level. To be sure, when prices rise unexpectedly the firm enjoys higher profits in the short run while workers suffer a temporary shortfall in their real wage. However, the high short run profits can be used to compensate employees at the time of the next contract negotiation or even earlier by, for example, giving workers bonuses or extended vacation time.

A final criticism concerns a prediction that the contracts approach makes about the relationship between output and real wages. A segment of the workforce will have a given nominal
wage when prices rise. This means their real wage (W/P) falls at the same time that output rises. If demand shocks coupled with nominal wage contracts are strong and important factors in fluctuations in real output, then we should observe a negative correlation between real wages and real output. Real world data does not exhibit a strong, or even a weak, negative correlation between these two variables, but instead, as we learned in the chapter 10 on the labor market, the data shows a positive relationship. Thus, the theory makes a prediction that is not born out by the data.

Some care must be taken in the interpretation of this last criticism. The failure of the data to show a strong negative correlation between real wages and output may arise because nominal wage contracts together with demand shocks are not an important source of business cycle, but the failure may also arise because other types of shocks, like supply side shocks, are also important sources of variations in real output. For example, suppose a temporary positive shock to the production function increases the marginal product of labor. Firms want to hire more workers since productivity has increased. To attract these additional workers firms offer a higher real wage. In this case output will increase at the same time that real wages increase. Now, if half the increases in output are caused by increases in aggregate demand along the lines discussed above, and half are caused by temporary positive shocks, then half the time you will observe a fall in real wages, but the other half of the time you will see a rise in real wages. These movements tend to cancel out and on average there will not be any correlation between changes in output and real wages. Therefore the absence of a negative correlation between real wages and output only allows us to conclude that demand shocks in tandem with nominal wage contracts are not the dominant source of variations in real output.

b. criticism of the imperfect information rationale

The imperfect information rationale for a positively sloped AS curve rests on the assumption that households do not have accurate information on the price level. Is this assumption plausible for a modern economy? First, note that workers are made worse off by an increase in
the money supply. They work harder, and end up being paid a lower real wage than they had expected. The realization that prices have risen comes as an unpleasant surprise. Because workers are harmed by their ignorance they have an incentive to acquire information, and if information is easily available at low cost we would expect households to take advantage of it. In the U.S. price level information is available monthly free of charge. Each month the Bureau of Labor Statistics announces the consumer price index for the past month at a well publicized press conference. The news is then carried across the nation by all the media. In short, timely and inexpensive price level information is readily available in the U.S.

Many economists therefore find it hard to believe that people would not avail themselves of this information if they were truly harmed by their ignorance. As a result, many question the empirical significance for a modern country of this source of a positively sloped AS curve.

Another criticism of this approach lies in the prediction that it makes about quit rates. Consider the effect of a decrease in aggregate demand on a worker's likelihood of quitting. When aggregate demand falls, the price level falls, and firms want to lower nominal wages. Workers interpret the lower nominal wage offer as an offer of a lower real wage, and at least some reject the offer, and quit to look for new jobs. Employment and output decline, and unemployment increases. This suggests that quit rates should be high when unemployment is high and output is low. This is exactly opposite to what we observe. We observe high quit rates when unemployment is low, not when it is high. The prediction of the imperfect information approach on the relationship between the quit rate and economic activity is far off the mark.

The imperfect information rationale is also subject to same criticism as the nominal wage contract rationale with regard to its prediction of real wage behavior. The imperfect information argument implied that, although workers believed that their real wage increased, actual real wages fell. This means that real wages ought to move countercyclically, and they don't. The two rationales share this shortcoming.

There is one final criticism that has been leveled against both approaches. If demand shocks, such as changes in the money supply, are important contributors to economic fluctuations, these models suggest that the price level should be procyclical. Our guiding facts are that, if anything, the price level is mildly countercyclical.

Extensions
There are two important issues that are closely related to the matters discussed in this chapter and we take each in turn. The first is the Phillips curve. Much of the analysis that surrounds aggregate supply was first developed to understand this curve. Second, we mentioned John Maynard Keynes in our discussion of investment, but Keynes' contribution to macroeconomics is far larger than that small mention suggests. His book, *The General Theory*, marks the birth of macroeconomics. We discuss some of his other ideas below, but we still just scratch the surface.

a. the Phillips curve

The intellectual forerunner of the aggregate supply curve is the Phillips curve. In 1958 the British economist A.W. Phillips reported on a scatter diagram of the rate of growth in nominal wages against the unemployment rate in Britain for the years 1861 through 1957. The scatter diagram revealed a negative relationship between the two variables. Two years later Paul Samuelson and Robert Solow, both of whom would later win the Nobel prize in economics for the importance of their wide ranging contributions to economics, imported this idea and modified it somewhat by plotting the inflation rate against the unemployment rate for U.S. data. The modified Phillips curve, based on data from 1935 to 1960, is shown in Figure 22.10.

At first glance, the Phillips curve suggests a trade-off between inflation and unemployment, higher inflation brings lower unemployment. In 1960 it appeared that the unemployment rate would have to reach about 5 1/2% to allow inflation to be zero. The Phillips curve remained relatively reliable for the next decade. A plot of the Phillips curve from 1950 to 1969 is shown in Figure 22.11 and it reveals a distinct, and apparently stable, trade-off.

Policy discussions in the 1960s and into the 1970s often revolved around the "cruel trade-off between inflation and unemployment," and finding the "best point" on the Phillips curve became an important question. Those with soft hearts preferred soft money, while those who

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favored hard money were considered hard hearted. However, the discussion of the policy trade-off had ignored Samuelson and Solow's prophetic warning. They wrote in 1960

It would be wrong, though, to think that our Figure 2 (similar to the curve shown below in our Figure 22.10) menu that relates obtainable price and unemployment behavior will

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**Figure 22.10 Phillips Curve: 1935 - 1960**

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**Figure 22.11 Phillips Curve: 1950 - 1969**

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Data source: Historical Statistics of the United States and Economic Report of the President
maintain its shape in the longer run. What we do in a policy way during the next few years might cause it to shift in a definite way.

The trouble arrived in the early 1970s when the trade-off began to deteriorate. Figure 22.12 shows a plot for the 1950 to 1979 period and, if anything, there appears to be a positive relationship between inflation and the unemployment rate. The 1970s were a time of both rising unemployment rates and rising inflation rates, a combination which gave birth to the term \textit{stagflation}. Apparently, the Phillips curve was shifting out in a northeasterly direction.

The question then became what caused the Phillips curve to shift. An answer had been provided before the fact by Milton Friedman and, independently, by Edmund Phelps.\footnote{E. Phelps "Phillips Curves, Expectations of Inflation, and Optimal Unemployment Over Time" \textit{Economica}, 34, 1967, and M. Friedman "The Role of Monetary Policy" \textit{American Economic Review}, 58, 1968.} They argued that in the long run the Phillips curve was vertical. There is no long run relationship between the unemployment rate and inflation rate. Instead, in the long run unemployment is determined by real factors, such as the existence and level of unemployment insurance, the frequency of job turnover, and the like. In the long run, unemployment is independent of inflation. These arguments are analogous to the arguments that explain why the long run aggregate supply curve is vertical.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{Phillips_Curves.png}
\caption{Phillips Curves: 1950 - 1979}
\end{figure}

\textit{Figure 22.12} Phillips Curves: 1950 - 1979

data source: see Figure 22.10
However, in the short run, when inflation is unexpected and wages and prices do not adjust promptly, an increase in the inflation rate lowers the unemployment rate. The reasoning behind this result is very similar to the reasoning behind the shape of the short run AS curve. In the face of nominal wage contracts or imperfectly informed workers, an unexpected increase in the inflation rate will increase work effort and output, and lower unemployment. Unemployment declines because workers either accept jobs more quickly since they believe that they are receiving high real wage offers, or because employment grows from a pool of initially unemployed workers. But, this only lasts for awhile. Once workers recognize the more rapid increase in prices, unemployment returns to its long run, or, as Friedman called it, its natural rate.

To see how this adjustment shifts the Phillips curve consider Figure 22.13. In this figure the natural rate of unemployment is 5.7% and the inflation rate is 4%. Now suppose that the inflation rate rises unexpectedly to 6%, perhaps because of a more rapid rate of money growth. Real wages in those industries that are locked into nominal wage contracts begin to deteriorate more rapidly. If there is a pool of unemployed workers waiting for these jobs, firms are inclined to hire them. Also, the more rapid inflation induces firms to raise their nominal wages more rapidly. Ill informed workers misinterpret this increase in nominal wages as an increase in real wages, and are more willing to accept job offers. Both of these forces work to lower the

![Figure 22.13 The Adjustment of the Phillips Curve to an Unexpected Increase in the Rate of Inflation](image-url)
unemployment rate to, say, 5%. This moves the economy along the original Phillips curve from point A to point B.

As soon as workers become aware of the rapid price increase or are allowed to renegotiate their contracts, they will bargain for more generous pay increases to offset the now higher rate of inflation. As these adjustments take place a 6% inflation rate can no longer sustain a 5% unemployment rate, and the unemployment rate returns to its natural level. The inflation rate stays at 6%, and so this means that the short run Phillips curve shifts up and to the right. The new curve passes through point C.

The natural rate of unemployment is not necessarily fixed, and may change over time as conditions in the labor market and the rest of the economy change. For example, an increase in the duration and amounts of unemployment insurance will increase the natural rate, while if more resources are devoted to retraining and placement, the natural rate will fall. Changes in the demographic composition of the workforce may also affect the natural rate. For example, younger people tend to switch jobs more frequently and thus experience more spells of unemployment. As a result, a baby boom, once the babies begin to enter the workforce, may raise the natural rate of unemployment. Figure 4.1 showed a tendency for the unemployment rate to be higher in the 1970s than it was in the previous two decades. During this period many changes were also occurring in the labor market. The labor force was becoming younger, more women were participating, and transfer programs were expanding. These changes may have increased in the natural rate of unemployment.

b. demand determined output
Until the oil price shocks in the 1970s most economists believed that the demand side of the economy played a far more important role in short-run economic fluctuations than did the supply side. The foundation for this claim laid in the belief that the economy in general and prices in particular adjusted very slowly to shocks. If this is the case, then the economy may be away from equilibrium for an extended period.

To begin suppose that there has been a demand shock of some sort, but prices have not begun to change. In Figure 22.14 the economy is at point K. So long as prices fail to fall, the economy is stuck at the output level \( Y^K \). Producers would like to supply \( Y^{\text{long run}} \), but they would be unable to sell all the units if they did. Roughly speaking, this is what John Maynard Keynes believed had happened in the 1930s. The economy suffered from a lack of aggregate demand and the self adjustment mechanisms of the economy were either painfully slow to work or absent.

A very simple version of this idea leads to the notion of income determination and the Keynesian multiplier. First, assume that the interest rate is constant. The same basic results hold if it is not, but the exposition is more complicated. Also, suppose that some of any change in income is thought to be permanent and some is thought to be temporary. This means that the marginal propensity to consume will be between 0 and 1. For example, if income decreases by $100 and half of it is taken as permanent and the other half as temporary, then consumption will decrease by $50. The marginal propensity to consume is 1/2.

Aggregate demand is given by

\[
Y^d = C^d + I^d + G
\]

The simplest form of the consumption function is just

\[
C^d = C^A + b \cdot Y
\]

where \( Y \) is the actual level of current income, \( C^A \) is called autonomous consumption and is that part of consumption that depends on the interest rate and future income, and \( b \) is the marginal propensity to consume, now assumed to be between 0 and 1. Since output is demand determined, it must be the case that \( Y^d = Y \), and we may write
\[ Y = C^A + b\cdot Y + I^d + G. \]

The three terms \( C^A, I^d, \) and \( G \) are lumped together and called autonomous spending because none of them depends on current income, \( Y \). For short, we write \( A = C^A + I^d + G \). The actual level of income can now be written down more compactly as

\[ Y = A + b\cdot Y, \]

and the actual level of income can be found with simple algebra. It is

\[ Y^K = A/(1 - b). \]

We label it \( Y^K \) for the Keynesian; that is, demand determined, level of income, and it can be easily calculated for given levels of \( A \) and \( b \). For example, if \( A \) is 15,000 units and \( b \) is 1/2, then \( Y^K \) is 30,000. Under these assumptions autonomous spending and the marginal propensity to consume determine income.

What happens to the Keynesian level of income when autonomous spending changes? Again, simple algebra provides the answer. Let

\[ Y^K = A/(1 - b) \]

be the first level of output and

\[ Y^K' = A'/1 - b \]

be the second level of output. The marginal propensity to consume, \( b \), is the same in both cases. To find the change in income, we just subtract \( Y^K \) from \( Y^K' \) to get

\[ Y^K' - Y^K = A'/1 - b - A/(1 - b), \]
which can be written as

\[ \Delta Y^K = \left[ \frac{1}{1 - b} \right] \Delta A. \]

The term in square brackets is called the Keynesian multiplier and, since \( b \) is between 0 and 1, the multiplier is greater than one. For example, if the marginal propensity to consume is \( 1/2 \), the multiplier is 2. This means that an increase in, say, investment spending of 20 units would increase income by 40 units.

What is the reasoning behind the multiplier? When output is demand determined sellers are demand constrained. They would like to produce more output, but no one is there to buy it. So, when investment spending increases by 20 units, producers are more than willing to supply this output, and in the first stage output increases by 20 units. But one person's output is another person's income, and since the seller's income has increased, their consumption will increase also. Indeed, we know by how much consumption will increase. It increases by the marginal propensity to consume times the change in income. In our example this is 20 units times \( 1/2 \), or 10 units. This spending increases someone else's income by 10 units and this, in turn, leads to another increase in consumption-this time by 5 units. The story doesn't stop here, it keeps going ad infinitum. The first few stages are recorded in Table 22.1.

<table>
<thead>
<tr>
<th>stage</th>
<th>change in income: example</th>
<th>change in income: general</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20</td>
<td>( \Delta A )</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>( b \Delta A )</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>( b^2 \Delta A )</td>
</tr>
<tr>
<td>4</td>
<td>2 1/2</td>
<td>( b^3 \Delta A )</td>
</tr>
<tr>
<td>and so on</td>
<td>and so on</td>
<td>and so on</td>
</tr>
</tbody>
</table>
Now it is time to add up all the changes in income. It is easiest to do this for the general case. The sum is

\[ \Delta Y^K = \Delta A + b\Delta A + b^2\Delta A + b^3\Delta A + \cdots, \]

and factoring out the \( \Delta A \) gives us

\[ \Delta Y^K = \Delta A[1 + b + b^2 + b^3 + \cdots]. \]

The series in square brackets is called a geometric series and, when \( b \) is between 0 and 1, it equals\(^{41}\)

\[ [1 + b + b^2 + b^3 + \cdots] = \frac{1}{1 - b}. \]

This is just the multiplier again. The intuition in the above example is fairly straightforward. Suppliers are constrained by insufficient demand. When demand increases this constraint is relaxed and output increases. This leaves a seller with additional income some of which he spends. This relaxes the constraint for another seller and the process continues.

Animal spirits and investment, demand determined output, and the multiplier are just a small sample of the ideas of Keynes. These and others spawned the discussions that have grown into modern macroeconomics. Many of the advances in the past 50 years were begun as extensions of Keynes or attempts to answer questions that he raised. Examples include the development of the consumption function, portfolio theory, and macroeconomic forecasting. There are few, if any, other economists who have stimulated so much thought.

**Summary**

Many economists have criticized the real business cycle model for its assumption that the work effort decision reacts significantly to changes in the interest rate. The critics argue that the

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\(^{41}\) How do we know this? Whatever the sum is call it \( S \), so \( S = 1 + b + b^2 + b^3 + \text{ and so on. } \) If we multiply \( S \) by \( b \) we get that \( bS = b + b^2 + b^3 + \text{ and so on. } \) Subtracting \( bS \) from \( S \) yields \( S - bS = (1-b)S = 1, \) so \( S \) must equal \( 1/(1-b). \)
Y* curve is most likely vertical. In this case demand shocks cannot affect real output, and this, to many people, seems implausible. In this chapter we developed an alternative model that allows demand shocks to be important, but does not rely on the interest rate affecting the work effort decision. Instead, the model depended on sticky wages. These models are not without their critics. We conclude our discussion by noting that how demand shocks affect real output remains a topic of current research.

Review Questions

1) What are the criticisms of the real business cycle model that lead many economists to look for an alternative?

2) Compare the results of a temporary increase in government spending in real business cycle model and the sticky wage model. Be sure to compare the reasoning behind the two results.

3) Carefully explain the effect of a decrease in the money supply on real output and prices in the short run. What is the effect on the interest rate and investment?

4) In the early nineteenth century, the U.S. did not have trade unions and the government did not collect and disseminate large quantities of economic data. In this setting, which of the explanations for an upward sloping short run AS curve seems the most plausible?