CHAPTER

25 Aggregate supply, prices, and adjustment to shocks

LEARNING OUTCOMES

By the end of this chapter, you should understand:

- The macroeconomic demand schedule MDS
- Aggregate supply in the classical model
- The equilibrium inflation rate
- Complete crowding out in the classical model
- Why wage adjustment may be slow
- Short-run aggregate supply
- Temporary and permanent supply shocks
- How monetary policy reacts to demand and supply shocks
- Flexible inflation targets

Keynesian models suggest that higher aggregate demand always raises output. But prices are not fixed forever. However, with finite resources, the economy cannot expand output indefinitely. Nor are prices fixed for ever. Having analysed aggregate demand, we now introduce aggregate supply – a firm's willingness and ability to produce – and show how demand and supply together determine output. Introducing supply means that we finally abandon the simplifying assumption that output is determined by demand alone.

To get started, we swap the Keynesian extreme, with fixed wages and prices, for the opposite extreme, full wage and price flexibility.

The **classical model** of macroeconomics assumes wages and prices are completely flexible.

In the classical model, the economy is *always* at full capacity. Any deviation of output from full capacity causes instant price and wage changes to restore output to potential output. In the classical model, monetary and fiscal policy affect prices but not output.

In the short run, before prices and wages adjust, the Keynesian model is relevant. In the long run, once all prices and wages have adjusted, the classical model is relevant. We examine how the economy evolves from the Keynesian short run to the classical long run. Finally, we study how the economy responds differently to demand shocks and supply shocks.

We now study three markets: for goods, money, and labour. Aggregate demand reflects the interaction of the markets for goods and money. That part you now know. The new part is aggregate supply, which reflects the interaction of the markets for goods and labour.

25–1 Inflation and aggregate demand

Inflation is the growth rate of the average price of goods and services.

Chapter 24 viewed a given monetary policy as a Taylor rule. Interest rates respond to both output

and inflation. Target inflation π^* is usually 2 or 2.5 per cent a year. Effectively, this is price stability: the quality of goods rises every year, and better goods cost a little more. Target output is potential output Y^*. If i^* is the real interest rate, π the inflation rate, Y real output, and a and b are positive constants

$$i = i^* + a(\pi - \pi^*) + b(Y - Y^*) \quad a > 0, b > 0 \tag{1}$$

In the UK, the Chancellor sets the Bank of England's inflation target π^* to use (currently 2.5 per cent). Central banks caring a lot about inflation, but only a little about output, choose a large value of a and small value of b. Central banks caring more about output have a larger value of b.

In the long run, output is Y^*, inflation is π^*, and the real interest rate is i^*. In long-run equilibrium, aggregate demand $(C + I + G + NX)$ must equal potential output Y^*. Real interest rates affect consumption and investment demand. Hence, given the level of net exports, fiscal policy, and the autonomous elements of consumption and investment demand, there is only one level of the target interest rate i^* consistent with long-run equilibrium.

In the short run, Equation (1) shows how the real interest rate temporarily deviates from its long-run level i^* because inflation and output have deviated from their long-run values. The real interest rate is chosen to push inflation and output back towards their target levels. The constants a and b measure how actively the central bank reacts to deviations of output and inflation.

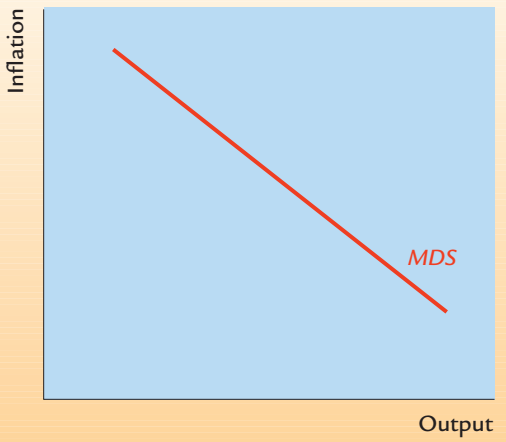
Of course the central bank actually sets the nominal interest rate r not the real interest rate i. By definition, $r \equiv i + p$. The nominal interest rate is the real interest rate plus the inflation rate. Knowing inflation, and the real interest rate that it wants, the central bank works out what nominal interest rate to set.

If inflation rises by 1 percentage point, the Taylor rule in Equation (1) says that the *real* interest rate is raised to reduce aggregate demand. Hence, a rise in inflation should induce a *larger* rise in the nominal interest rate, in order to raise the real interest rate.[1]

When monetary policy follows a Taylor rule, higher inflation makes the central bank raise the real interest rates, thus reducing aggregate demand and output. Hence, higher inflation is associated with lower aggregate demand and lower output.

[1] Across time and across countries, higher inflation is often matched by higher nominal interest rates. Real interest rates do not change much. The data picks up the relative constancy of i^* in the long run. For short-run data for a single country, nominal interest rates to vary *more* than inflation, reflecting the Taylor rule in Equation (1).

Figure 25–1 The macroeconomic demand schedule



The macroeconomic demand schedule *MDS* shows combinations of output and inflation at which planned spending equals output and the interest rate is set by the Taylor rule.

Figure 25–1 illustrates this macroeconomic demand schedule. It shows aggregate demand for goods when the money market is in equilibrium. It recognizes that output and inflation affect interest rates, which in turn affect aggregate demand for goods. The chosen interest rate is compatible with money market equilibrium because the central bank then passively supplies whatever money is demanded at this combination of output and interest rates.

The **macroeconomic demand schedule *MDS*** shows combinations of inflation and output at which planned spending equals actual output, *and* the interest rate is set by the Taylor rule.

Movements *along* the macroeconomic demand schedule *MDS* show how inflation makes the central bank alter real interest rates and thus aggregate demand. The schedule is flat, and lower inflation causes a big rise in aggregate demand, when (a) interest rate decisions react a lot to inflation and (b) interest rates have a big effect on aggregate demand. The *MDS* is steep when (a) interest rate decisions do not respond much to inflation and (b) changes in interest rates have a small effect on aggregate demand

Shifts in the *MDS* reflect all other shifts in aggregate demand not caused by the effect of changes in

inflation on real interest rate decisions. Thus, *MDS* shifts up if fiscal policy eases, net exports rise, or monetary policy eases (lower i^*, or higher π^*).

The macroeconomic demand schedule relates aggregate demand, output, and inflation. Next we turn to aggregate supply.

25–2 Aggregate supply

The **aggregate supply schedule** shows the output firms wish to supply at each inflation rate.

When prices and wages are completely flexible, output is always at potential output.

At **potential output** all inputs are fully employed. It is long-run equilibrium output.

Potential output depends on the level of technology, the quantities of available inputs (labour, capital, land, energy) in long-run equilibrium, and the efficiency with which resources and technology are exploited. In the long run, investment in physical and human capital raise inputs of labour and capital, technical progress improves technology, and supply-side policies reduce distortions and raise efficiency. In the short run, we treat potential output as given.

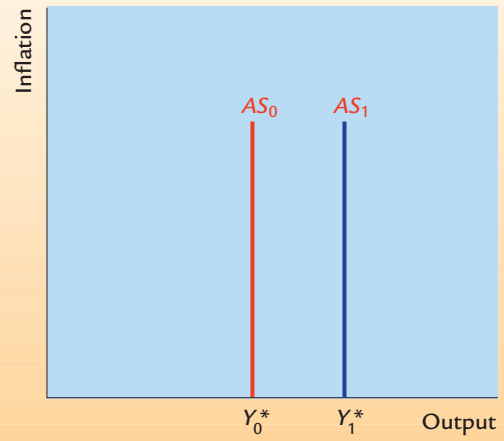
With flexible wages and prices, how does a rise in inflation (and correspondingly faster growth of nominal wages) affect the incentive of firms to supply goods and services?

Money illusion exists if people confuse nominal and real variables.

Thinking in real terms, firms compare the real wage (the nominal wage W divided by the price level P) with the real benefit of labour, the extra output it makes. Similarly, workers compare real take-home pay (its purchasing power over goods and services) with the disutility of sacrificing more leisure in order to work longer. If wages and prices both double, real wages are unaffected. Neither firms nor workers should change their behaviour. Aggregate supply is unaffected by pure inflation since everything nominal rises by the same proportion, as shown in Figure 25–2.

In the classical model, the **aggregate supply schedule** is vertical at potential output. Equilibrium output is independent of inflation.

Figure 25–2 The vertical *AS* schedule



In the classical model, aggregate supply equals potential output, whatever the inflation rate. The *AS* schedule is vertical. A rise in potential output, from Y^*_0 to Y^*_1 shifts aggregate supply from AS_0 to AS_1.

Wage and price flexibility ensures all nominal variables rise together. Without money illusion, people see through nominal changes, recognizing that real variables are unaltered. In the classical model, real things determine real things, and nominal things determine other nominal things. Better technology, more capital, or greater labour supply raise potential output, shifting the vertical supply curve from AS_0 to AS_1 in Figure 25–2. However, for any given level of potential output, lower inflation does *not* reduce the real output that firms wish to supply.

25–3 Equilibrium inflation

For the classical model, Figure 25–3 shows the macroeconomic demand schedule *MDS* and the vertical aggregate supply schedule AS_0. Output is at potential output and inflation is π^*_0. At point *A* there is equilibrium in all markets: for output, money, and labour.

The labour market is in equilibrium anywhere on the *AS* schedule, since the economy is at potential output and full employment. *A* is also on the macroeconomic demand schedule along which interest rates are adjusted in line with monetary policy and the aggregate demand for goods equals the actual output of goods.

What determines inflation?

The equilibrium inflation rate π^*_0 reflects the positions of the *MDS* and *AS* schedules. Potential output Y^* reflects technology, efficiency, and available input supplies. The macroeconomic

Box 25–1 Anchors away!

When prices can change, monetary policy must provide a nominal anchor. Some real variables are the ratio of two nominal variables. If one nominal variable is fixed, this determines the level of other nominal variables to get the right real values in equilibrium. The intermediate target of monetary policy fulfils the role of nominal anchor.

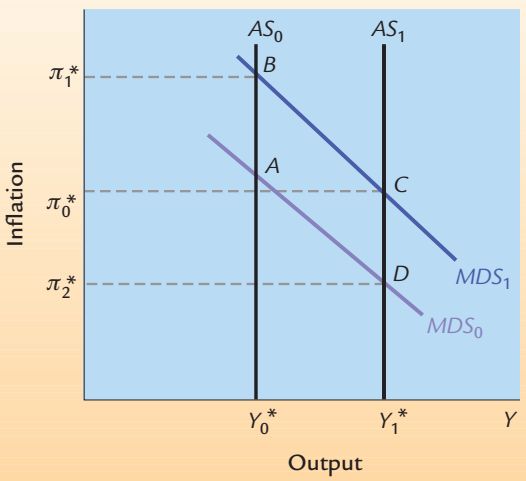
A **nominal anchor** eventually determines the level of other nominal variables. Market forces determine real variables.

Imagine there is no intermediate target, and the interest rate r is simply fixed. In the classical model, output is Y^*. Y^* and r determine money demand M/P. Nominal money M is passively supplied to get the right level of real money M/P.

If the market imagines P will be larger, the Bank supplies more nominal money M to maintain the correct M/P. Any price level can be the equilibrium price level! The economy has no nominal anchor, no starting point, even though there is only one inflation rate from now.

An intermediate target of nominal money M is a possible nominal anchor. Money demand still determines M/P but, with M known, the market knows where to set the equilibrium price level P. Conversely, think of an inflation target as a target for P. Knowing last period's price level, the Bank targets a particular level of this period's price level, say P^*. Output and interest rates determine money demand M/P^*, and hence imply a unique level of M. Similarly, if monetary policy follows a Taylor Rule, interest rates are adjusted to restore output to potential output and inflation to target inflation. Target inflation, relative to last period's price level, again provides the nominal anchor. Later we show a nominal exchange rate can also act as a nominal anchor.

Figure 25–3 Equilibrium inflation



With aggregate supply AS_0 and macroeconomic demand MDS_0, inflation is π^*_0 and output is Y^*_0. For a given aggregate supply, a rise in demand from MDS_0 to MDS_1 violates the long-run inflation target at π^*_0. Thus the central bank raises i^* to shift MDS_1 back to MDS_0 and restore equilibrium at A. Conversely, a rise in supply shifts aggregate supply from AS_0 to AS_1. The central bank accommodates this extra supply, reducing i^* in order to shift demand to MDS_1 thus maintaining equilibrium inflation at π^*_0. Equilibrium then shifts from A to C.

demand schedule reflects the Taylor rule and the *IS* schedule showing how interest rates affect aggregate demand.

A supply shock Supply shocks may be beneficial, such as technical progress, or may be adverse, such as higher real oil prices or loss of capacity after an earthquake. Suppose potential output rises. In Figure 25–3 the *AS* schedule shifts to the right, from AS_0 to AS_1. For a *given MDS* schedule, it appears that equilibrium inflation falls to π^*_2 and that the new equilibrium is at D.

However, the central bank still wants a long-run equilibrium inflation rate π^*_0 when output is at potential output. Hence, in response to the supply shock, the central bank must reduce its target real interest rate i^* if aggregate demand is to match the higher potential output Y_1^*. The new equilibrium is at C not D.

Monetary policy accommodates a permanent supply change by altering the target real interest rate i^* to achieve a corresponding change in aggregate demand.

Lower interest rates raise the demand for money. To make the lower interest rate compatible with money market equilibrium, the central bank must then supply more money.

A demand shock The macroeconomic demand schedule reflects both the *IS* schedule and the Taylor rule. Suppose the *IS* schedule shifts up because fiscal policy is eased or because the private sector is more optimistic about future incomes and profits. Beginning from equilibrium at A in Figure 25–3, but keeping supply fixed at AS_0, a demand shift from

MDS_0 to MDS_1 appears to lead to a new equilibrium at *B*. Again, we must think about how monetary policy responds.

Facing a permanent demand increase, but no change in potential output, the central bank can continue to hit its inflation target π^*_0 only by tightening monetary policy to offset the demand shock. If full equilibrium, with unchanged supply AS_0, aggregate demand must not change. By raising the target real interest rate i^*, the central bank uses monetary policy to offset fully the demand shock and shift MDS_1 down to MDS_0 again. Equilibrium remains at *A* and the inflation target π^*_0 is still achieved.

The original rise in demand could have come from the private or the public sector. If it was higher private demand, the higher real interest rate simply reduces private demand back to its original level. If it was higher government spending, the central bank raises interest rates until private spending falls by as much as government spending increased.

In the classical model with a vertical *AS* schedule, **a rise in government spending crowds out an equal amount of private spending**. Aggregate demand remains equal to potential output.

Note the distinction between partial crowding out in the Keynesian model and complete crowding out in the classical model. In the Keynesian model, output was demand-determined in the short run. Higher *output* induced the central bank to raise interest rates, which partly offset the expansionary effect of higher government spending.

In the classical model, aggregate supply is the binding constraint. Output does not change. When higher government expenditure raises aggregate demand, higher interest rates must reduce consumption and investment to leave aggregate demand unaltered.

We draw a second conclusion from Figure 25–3. Suppose the rise in the aggregate demand reflects not a fiscal but a monetary expansion, in the form of a rise in the inflation target from π^*_0 to π^*_1.

With a higher target inflation rate, the central bank no longer needs such high real interest rates at any particular level of inflation. Real interest rates fall and the macroeconomic demand schedule shifts up from MDS_0 to MDS_1. With an unchanged *AS* schedule, equilibrium moves from *A* to *B*.

In the new equilibrium, inflation is higher but real output is unaltered. Since it is a full equilibrium, all real variables are then constant. One of these variables is the real money stock M/P. Since prices grow at the rate π_1^*, the nominal money supply must also grow at this rate.

In the classical model, **faster nominal money growth** is accompanied by higher inflation but leaves real output constant at potential output.

The idea that nominal money growth is associated with inflation, but not growth of output or employment, is the central tenet of *Monetarists*. Figure 25–3 shows this is correct in the classical model with full wage and price flexibility and no money illusion.

How long does this all take?

The classical model studies the economy once all variables have fully adjusted. Instead of thinking of adjustment as instant, we can view the analysis as applying to a long enough time for slower adjustment to be completed. This means not just wage and price adjustment, but time for the central bank to work out what is going on, amend monetary policy if necessary, and time for these interest rate changes to have their full effect on private behaviour. Suppose the economy faces a fall in aggregate demand. What happens next?

The classical model Knowing demand and output must soon equal Y^*, the central bank cuts the target interest rate target i^*, which boosts private sector demand, restoring aggregate demand to potential output.

The Keynesian model Before wages and price adjustment is possible, the initial effect of lower aggregate demand is a fall in output. The central bank has to decide if lower output reflects lower demand or lower supply. If it is lower supply, the central bank needs to tighten monetary policy to help reduce aggregate demand. If it is lower demand, the central bank needs to loosen monetary policy to help raise aggregate demand.

Even once lower demand is diagnosed and interest rates are cut it may take up to two years for this cut in interest rates fully to affect private sector demand. In the meantime, aggregate demand is still temporarily below potential output. This reduces wages and prices. Temporarily lower inflation induces a further cut in interest rates: the central bank responds to the inflation part of the Taylor rule as well as the output part. Eventually, aggregate demand is restored to potential output, and inflation reverts to its original rate.

The Keynesian perspective explains why it takes time to return to potential output. Only after all adjustment is complete, are we back in the classical world of long-run equilibrium. Thereafter, the way to raise

output is not to boost aggregate demand but raise potential output.

Supply-side economics is the pursuit of policies to increase aggregate supply.

Supply-side policies include policies to boost labour supply, policies to boost capital investment, and policies to reduce distortion and inefficiency. We examine them in Chapter 27, when we study unemployment in more detail.

The rest of this chapter studies the adjustment process by which the economy responds to an initial shock. To see how the economy makes the transition from the Keynesian short run to the classical long run, we introduce the short-run aggregate supply curve.

25–4 The labour market and wage behaviour

Downward shocks cause recessions lasting years not weeks. Why don't changes in prices and wages immediately restore potential output? Firms relate prices to costs. Wages are the largest part of costs. Sluggish wage adjustment to departures from full employment is main cause of slow adjustment of prices.

For both firms and workers, a job is often a long-term commitment. For the firm, it is costly to hire and fire workers. Firing entails a redundancy payment, and the loss of the expertise the worker had built up on the job. Hiring entails advertising, interviewing, and training a new worker in the special features of that firm. Firms are reluctant to hire and fire workers just because of short-term fluctuations in demand.

For the worker, looking for new jobs costs time and effort, and throws away experience, seniority, and the high wages justified by the high productivity that comes from having mastered a particular job in a particular firm. Like firms, workers care about long-term arrangements. Firms and workers reach an understanding about pay and conditions *in the medium term*, including how to handle fluctuations in the firm's output in the short run.

Adjusting labour input

A firm and its workers have explicit or implicit labour contracts, specifying working conditions. These include normal hours, overtime requirements, regular wages, and pay schedules for overtime work. The firm then sets the number of hours, within the limits of these conditions, depending on how much output it wishes to make in that week.

The firm's **labour input** is the number of labour hours it uses in a given period.

When demand falls and a firm has to cut its output, does it change hours or workers? Given the costs of hiring and firing labour, the firm initially reduces hours of work. Overtime ends, and factories close early. If demand does not recover, or declines further, firms start firing workers.

Conversely, in a boom a firm makes its existing workforce work overtime. Then it seeks temporary workers to supplement the existing labour force. Only when the firm is sure that higher sales will be sustained does it hire extra permanent workers.

Wage adjustment

Wages are not set in a daily auction in which the equilibrium wage clears the market for labour. Firms and workers both gain from long-term understandings. This mutual commitment partly insulates a firm and its workforce from temporary conditions in the labour market.

Nor can a firm and its workforce spend every day haggling. Bargaining is costly, using up valuable time that workers and managers could use to produce output. Although there are regular meetings to deal with minor grievances, the costs of bargaining about the firm's general wage structure mean that such negotiations are undertaken only infrequently. In the UK bargains are usually annual, but US bargains often cover a three-year period.

Bargaining costs mean wages change only at discrete intervals. Immediate wage adjustment to demand shocks is ruled out. At best, firms must wait until the next scheduled date for a revision in the wage structure. In practice, complete wage adjustment is unlikely to take place even then.

Even once unemployment rises, this may have little impact on wages. A new worker is a poor substitute for an existing worker familiar with the job and the firm. Moreover, long-term co-operation between a firm and its workforce matters more than short-term gains from forcing wages down a bit. The reputation of a firm as a good employer affects its ability to attract and retain its skilled workers in the long run.

If workers dislike fluctuations in wages, the firm may smooth out wage fluctuations to keep its workers happy. Compared with more flexible wages, the firm loses out when demand is low but gains when demand is high. Firms and workers may reach an implicit understanding that wages do not fall a lot in slumps nor rise a lot in booms.

Box 25–2 Global slowdown

'IMF says global slowdown will be worse than expected' reported *The Guardian* (19/12/01), citing a new IMF forecast of a deeper slowdown in 2002 than previously expected. 'Global growth will be the slowest since 1993.' Unlike previous recessions, this time the three leading economies – the US, Japan, and Germany – all stagnated at the same time. Nor did the IMF expect wage and price flexibility to solve the problem.

'In industrial countries, which remain the key engines of growth in the world economy, economic policies should help to sustain demand, especially given the synchronized nature of the slowdown. To date, monetary policy has appropriately been eased. On the fiscal side, additional stimulus presently under consideration in the United States could be helpful if implemented sufficiently rapidly, while demand is still weak. . . . In Europe, the automatic stabilizers should be allowed to operate in full' (*IMF World Economic Outlook*, December 2001). The Table shows the IMF's increasingly pessimistic forecasts.

Changing IMF forecasts of GDP growth

Forecast of		2001	2002
Forecast made at			
Dec 01	USA	1.0	0.7
	Euro area	1.5	1.2
	Japan	−0.4	−1.0
Oct 01	USA	1.3	2.2
	Euro area	1.8	2.2
	Japan	−0.5	0.2
May 01	USA	1.5	2.5
	Euro area	2.4	2.8
	Japan	0.6	1.5
Oct 00	USA	3.2	
	Euro area	3.1	
	Japan	3.4	

Source: IMF, *World Economic Outlook*, various issues.

Table 25–1 Adjustment in the labour market

	Short run (3 months)	Medium run (1–2 years)	Long run (4–6 years)
Wages	Largely given	Beginning to adjust	Clearing the labour market
Hours	Demand-determined	Hours/employment mix adjusting	Normal work week
Employment	Largely given		Full employment

Chapter 10 discussed other reasons why involuntary unemployment is not instantly eliminated by wage adjustment. We grouped these arguments under the headings of trade union effects, the effect of scale economies, insider–outsider effects, and arguments based on efficiency wages when information on worker quality and effort is expensive for the firm to collect. To refresh your memory, reread Section 10–7 before continuing with this chapter.

Recap

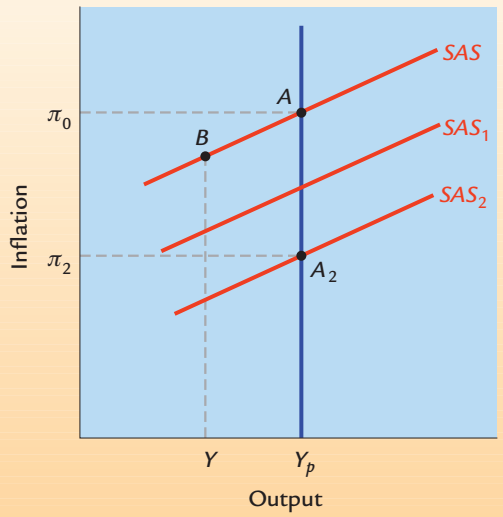
Table 25–1 summarizes our discussion. It shows adjustment in the short run, the medium run, and the long run. Based on the empirical evidence, we also show how long each of these 'runs' might be: three months for the short run, one to two years for the medium run, and four to six years for the long run. It is precisely on this assessment that macroeconomists disagree. Many monetarists think that adjustment is faster than we suggest, some Keynesians think it much slower. Our assessment reflects the mainstream view.

In the short run, variations in labour input are largely changes in hours. In the medium run, as changes in labour demand persist, the firm begins to alter its permanent workforce. In the long run, adjustment is complete.

In the short run, the wage structure in a firm is largely given. The firm has some flexibility over earnings, as distinct from negotiated wage rates, because fluctuations in overtime and short time affect average hourly earnings. But this flexibility is limited. In the medium run, the firm begins to adjust the wage structure. In the long run, the process is complete, and the economy is back on the vertical classical aggregate supply schedule at potential output.

We now use this analysis to think about the market for output. By distinguishing supply in the short run and the long run, our model of output reflects *both* supply and demand, even in the short run. Nevertheless, its short-run behaviour is like the simple Keynesian case in which output is

Figure 25–4 Short-run aggregate supply



Firms raise prices when wage costs rise. Each short-run aggregate supply schedule reflects a different rate of inherited nominal wage growth. For any given rate, higher inflation moves firms up a given short-run supply schedule. A persisting boom or slump gradually bids nominal wage growth up or down, shifting short-run aggregate supply schedules. When these shift enough to restore to the rate at which *MDS* and *AS* intersect, potential output is restored.

demand determined. Its long-run behaviour is fully classical.

25–5 Short-run aggregate supply

In Figure 25–4 the economy is at potential output at *A*. In the short run, the firm inherits a given rate of nominal wage growth (not shown in the figure). The wage negotiations anticipated remaining in long-run equilibrium at *A* with inflation π_0. By keeping up with inflation, nominal wage growth expected to maintain the correct real wage for labour market equilibrium.

If inflation exceeds the expected inflation rate π_0, this helps firms by raising their output prices. The real wage is lower than expected. If this had been foreseen when wages were negotiated, the inherited nominal wage would have been higher. Firms take advantage of their good luck by supplying a lot more output. They can afford to pay overtime to ensure that the workforce cooperates, and may also take on temporary extra staff.

Conversely, if inflation is below π_0, the real wage is now higher than anticipated when the nominal wage was agreed. Since labour is now costly, firms cut back output a lot. They move from *A* to *B* in Figure 25–4. Firms move along the supply schedule *SAS* in the short run.

The **short-run supply curve *SAS*** shows how desired output varies with inflation, for a given inherited growth of nominal wages.

If demand and output remain low, the growth rate of negotiated nominal wages gradually falls. With lower wage growth, firms don't need to raise output prices so quickly. The short-run aggregate supply schedule shifts down from *SAS* to SAS_1 in Figure 25–4. Lower inflation moves the economy down its macroeconomic demand schedule, increasing the demand for goods. If full employment and potential output are still not restored, in the longer run negotiated wage growth falls again, leading to a short-run aggregate supply schedule such as SAS_2.

These short-run aggregate supply schedules give a realistic picture of adjustment to demand shocks. Because the short-run aggregate supply schedule is flat, a shift in aggregate demand leads mainly to changes in output not prices in the short run. This is the Keynesian feature. But deviations from full employment gradually change wage growth and short-run aggregate supply. The economy gradually works its way back to potential output. That is the classical feature. We now describe adjustment in more detail.

25–6 The adjustment process

We now combine the macroeconomic demand schedule with the short-run aggregate supply schedule to show how demand or supply shocks set up an adjustment process. In combining the *MDS* schedule and the *SAS* schedule, we assume that the goods market clears, even in the short run. Short-run aggregate supply gradually changes over time as wage growth adjusts to the rate that restores full employment and potential output, placing firms eventually on their long-run aggregate supply schedule.

Output is no longer demand-determined when aggregate demand lies below the level of potential output. In the short run, firms are also on their short-run supply schedules producing what they wish, *given the inherited nominal wages*.

However, sluggish wage adjustment prevents immediate restoration of full employment. When aggregate demand for goods falls, firms reduce output and employment. Since wages do not fall at once, there is involuntary unemployment. *Employment* is demand-determined in the short run.

Figure 25–5 shows a shift in the macroeconomic demand schedule because the target inflation rate is cut from π^* to π^*_3.

Box 25–3 Output gaps 1980–2002

The output gap (Y–Y^*) is the percentage deviation of actual output Y from potential output Y^*. Actual output is (relatively) easily measured. Each year the Paris-based Organization for Economic Cooperation and Development (OECD) makes estimates of potential output for all its member countries. The charts below show estimates for the UK, Germany and Finland. Positive output gaps are booms, negative gaps indicate slumps.

The figure shows the UK slump of the early 1980s, as the Thatcher government cut back demand to reduce inflation; the Lawson boom of the mid-1980s that led to renewed inflation; the Major recession in the early 1990s as policy was tightened to cut inflation again; and recovery after 1993.

Germany also had a slump in the early 1980s as it fought inflation from the second oil shock. In 1990, German Unification gave a massive boost to demand as investment in East Germany drained the West German budget. High interest rates were needed to offset fiscal expansion and reduce inflation, so demand then fell. We also show Finland, whose exports rose after the opening of trade with Russia, but then collapsed as the former Soviet Union imploded. Since the mid-1990s, Finland has made a strong recovery, helped by hi-tech firms like Nokia.

The OECD expects the output gaps to turn negative as economies slow down in 2002.

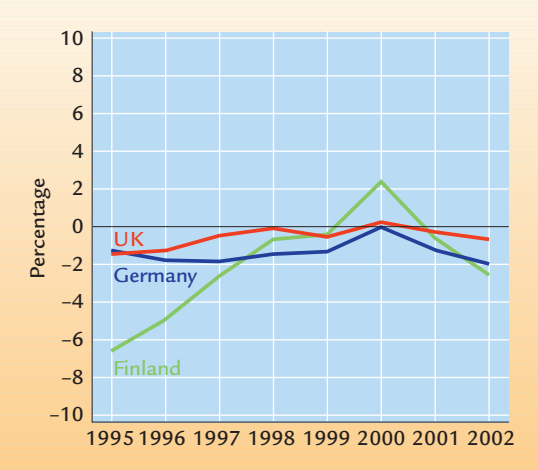
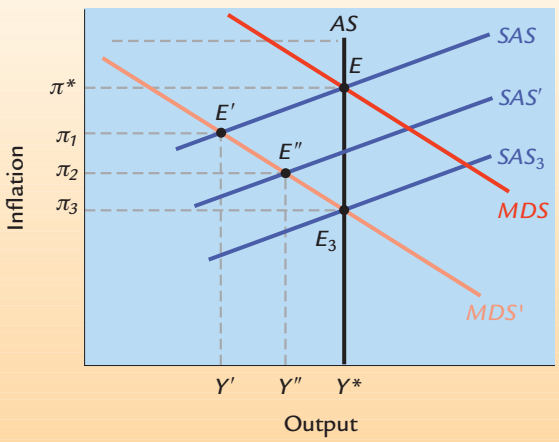


Figure 25–5 A fall in the nominal money supply



Beginning at E, a lower inflation target shifts MDS to MDS'. Given inherited wage growth, the new equilibrium is at E'. Output falls from Y^* to Y', and actual inflation is only π_1. Since wages have risen faster than prices despite the fall in output, unemployment rises. In the next wage settlement, nominal wage growth slows, and the short-run supply schedule becomes SAS'. Equilibrium is now at E'', and output recovers to Y''. Once wage growth slows enough to make SAS_3 the supply curve, long-run equilibrium is re-established at E_3.

When the inflation target is cut to $\pi_3{}^*$, interest rates are initially raised since actual inflation at E is now above target. Macroeconomic demand shifts down to MDS'. In the classical model there is an instant adjustment of prices and wages to keep the economy at full employment and potential output. Equilibrium inflation immediately falls to $\pi^*{}_3$ and the new equilibrium is at E_3. Output remains at potential output Y^*.

These classical results are valid only in the long run. What about the adjustment process while wages, and hence prices, are slow to adjust? When the inflation target is first cut, the economy faces the short-run aggregate supply schedule SAS, reflecting the nominal wages recently agreed.

In the short run, the downward shift in MDS causes a move from E to E'. Since firms can't cut costs much, they reduce output to Y'. At E' the goods market clears. It is on both the demand schedule MDS' and the supply schedule SAS. Inflation has fallen a little because of lower demand, but output has fallen a lot. With lower inflation than the expectation built into nominal wage agreements, *real wages have risen*, despite the fall in output. Once firms can adjust employment, some workers are fired and unemployment rises.

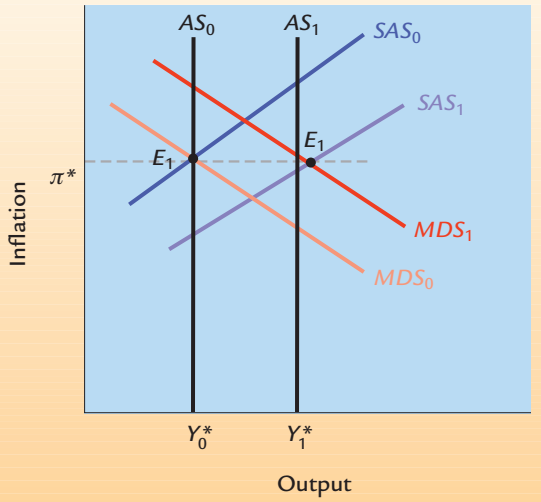
In the medium run, this starts to reduce wage growth. Firms move on to a lower short-run aggregate supply schedule SAS'. The goods market

now clears at E''. Output and employment recover a bit, but some unemployment persists. Since inflation has fallen, the central bank is less worried about the amount by which inflation exceeds its new target, and cuts real interest rates, moving the economy down MDS' to E''.

In the long run, adjustment is complete. Wage growth and inflation fall to π^*_3. The short-run aggregate supply schedule is SAS_3 in Figure 25–5. The economy is in full equilibrium at the E_3, on *AS*, *SAS*, and MDS'. Output is at Y^*, and the labour market is back at full employment.

The real world lies between the extreme simplifications of the simple Keynesian model and classical models. In practice, prices and wages are neither fully flexible nor fully fixed. A tougher inflation target has real effects in the short run, since output and employment are reduced. But after wages and prices adjust fully, output and employment return to normal. Inflation is permanently lower thereafter.

Figure 25–6 A permanent supply increase



A permanent rise in supply shifts AS_0 and SAS_0 to AS_1 and SAS_1. By permanently reducing interest rates, the central bank shifts MDS_0 to MDS_1, meeting its inflation target π^* in the new equilibrium at E_1. If the central bank acts quickly, no further shifts in SAS_1 are required.

25–7 Shifts in aggregate supply

A permanent supply shock

Suppose a change in attitudes towards women working makes more people wish to work at each real wage rate. Figure 25–3 already analysed the effects of a permanent rise in potential output.

In the long run, aggregate demand must rise in line with aggregate supply. This forces the central bank to cut its long-run real interest rate i^* in order to meet its inflation target π^*. Provided the central bank reacts rapidly enough to the supply shock, which is tough to do in practice, looser monetary policy induces a rightward shift in the *MDS* to match the rightward shift in aggregate supply. By accommodating the extra supply with looser monetary policy, the inflation rate remains π^*, and the economy moves directly to the new long-run equilibrium, as in Figure 25–6.

Because of lags in diagnosing the shock, and in the response of consumption and investment demand to lower interest rates, Figure 25–6 exaggerates the ease of adjustment to a permanent supply shock. In practice, output may not jump all the way to the new level of potential output.

However, the economy will then work its way to the final equilibrium following an adjustment process similar to that set out in Figure 25–5. If the macroeconomic demand schedule does not fully and immediately shift to MDS_1 in Figure 25–6, output is below Y^*_1. This reduces inflation, and the central bank responds with lower interest rates. Over time, the macroeconomic demand schedule will drift to the right until it reaches the position MDS_1 shown in Figure 25–6.

A temporary supply shock

A temporary supply shock leaves potential output unaffected in the long run. If it does not shift the *AS* schedule, vertical at potential output, it must shift the short-run supply curve. Although the *SAS* schedule is *mainly* influenced by inherited nominal wages, it is *also* affected by other input prices. Suppose a temporary oil price rise makes firms charge higher prices at any output level. Figure 25–7 shows a shift upwards in short-run supply, from *SAS* to SAS'. The new short-run equilibrium is at E'. Inflation rises but output and employment fall because the central bank raises real interest rates in response to higher inflation.

A **permanent supply shock** changes potential output. A **temporary supply shock** shifts the short-run aggregate supply schedule, but leaves potential output unaltered.

If the central bank maintains its inflation target π^*, lower output and employment at E' gradually reduce inflation and nominal wage growth, shifting SAS' gradually back to *SAS*. The economy gradually moves

down the *MDS* schedule back to the original equilibrium at *E*.

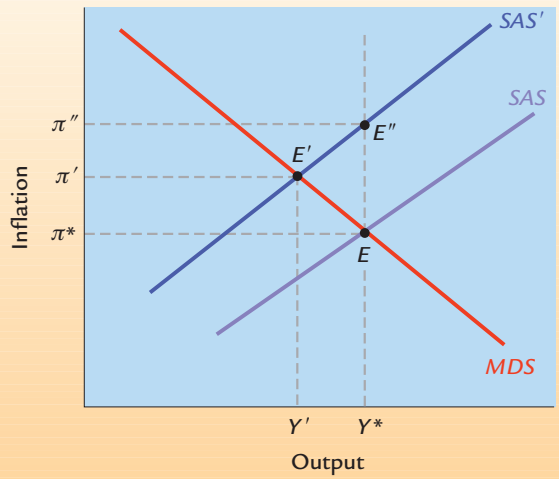
A second outcome is also possible. When the original rise in oil prices makes *SAS* shift up to *SAS'*, it is possible to avoid the period of low output as the economy moves along *MDS* from *E'* back to *E*. A *change* in monetary policy can *shift MDS* up enough to pass through *E''*. Output can quickly return to potential output, but only because the inflation target has been loosened from π^* to $\pi^{*\prime\prime}$. The new long-run new equilibrium is then at *E''*.

Monetary policy accommodates a temporary supply shock when monetary policy is altered to help stabilize output. The consequence, however, is higher inflation.

A central bank caring a lot about output stability may be prepared to accommodate short-run supply shocks, even if this means higher inflation. A central bank caring more about price stability will not accommodate temporary supply shocks.

It matters whether the supply shock is temporary or permanent. If potential output is permanently affected, aggregate demand must output eventually alter in line with the change in potential output. Once a supply-side shock is diagnosed as permanent, it should be accommodated.

Figure 25–7 A temporary supply shock



Higher oil prices force firms to raise prices. In the short run, *SAS* shifts up to *SAS'*, and equilibrium shifts from *E* to *E'*. Higher inflation reduces aggregate demand since the central bank raises real interest rates. Once the temporary supply shock disappears, *SAS'* gradually falls back to *SAS*, and eventual equilibrium is restored at *E*.

25–8 Monetary policy rules

A **monetary policy rule** shows how interest rates respond to changes in other economic variables

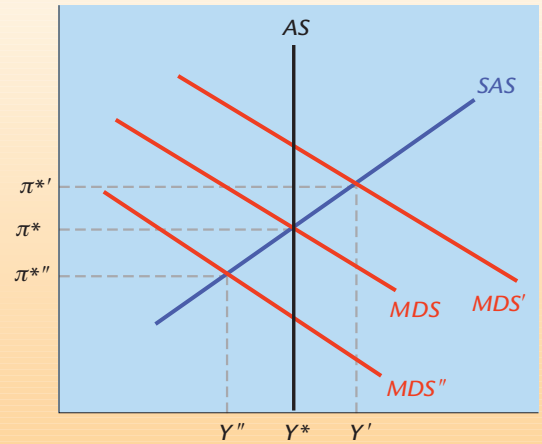
Any macroeconomic demand schedule embodies an assumption about the form of this rule, whether explicit or only implicit. Figures 25–8 and 25–9 show an economy in which policy has to react to shocks to demand and supply. In Figure 25–8 the only shocks are demand shocks *not* caused by monetary policy. If demand is high, facing *MDS'* the economy moves along its short-run supply curve to point *A*. If demand is low, facing *MDS''* the economy moves along the *SAS* curve to point *B*.

Suppose the central bank quickly diagnoses that an expansionary demand shock has occurred. It could tighten monetary policy and shift *MDS'* back down to *MDS* again. Similarly, it could loosen monetary policy whenever it thinks aggregate demand would otherwise have been *MDS''*. Since the economy then remains at *E*, both prices and output are stabilized

When all shocks are **demand shocks**, stabilizing inflation also stabilises output.

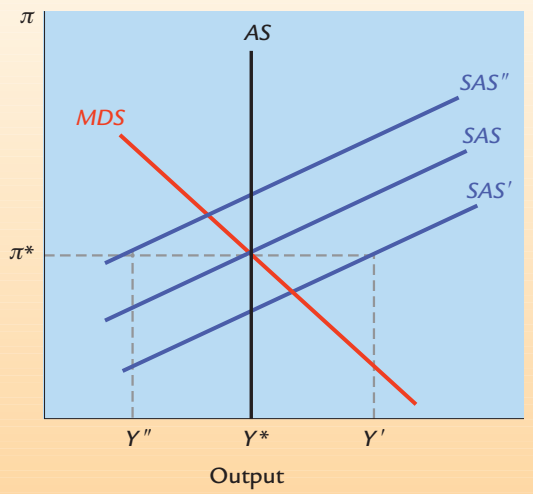
It is easy for the central bank to tell where inflation is relative to its target rate. It is harder to estimate the level of potential output, which can change over

Figure 25–8 Demand shocks



Demand fluctuates between *MDS'* and *MDS''*, causing fluctuations in output and inflation. If the central bank can react quickly, it can offset demand shocks by changing i^* to shift demand back to *MDS*. Stabilizing inflation at π^* has the effect of stabilizing output at Y*.

Figure 25–9 Temporary supply shocks



Short-run supply fluctuates between *SAS*′ and *SAS*″. If interest rates are set to stabilize inflation at π*, output fluctuates between *Y*′ and *Y*″. Monetary policy cannot stabilize both output and inflation in response to supply shocks. It makes sense to set interest rates to allow some inflation fluctuations in order to reduce output a bit. For the Taylor rule implied by *MDS*, the economy fluctuates between points *A* and *B*. A flatter *MDS* schedule would imply smaller inflation fluctuations but larger fluctuations in output.

time. In this sense, an inflation target is easier to implement than the Taylor rule shown earlier in Equation (1), which also requires estimates of how output differs from potential output. This is part of the modern case for using inflation targeting as the intermediate target of monetary policy. When all shocks are demand shocks, it works perfectly.

Suppose instead, that all shocks are supply shocks. Figure 25–9 shows the long-run supply curve *AS*, vertical at potential output *Y**, and a set of short-run supply curves whose average level is *SAS* but which fluctuate between *SAS*′ and *SAS*″.

On average, output is *Y** and inflation is π*. If interest rates are varied very aggressively to stabilize inflation in the face of supply shocks, the *MDS* schedule is effectively horizontal at π*. Inflation is stabilized, but output fluctuates between *Y*′ and *Y*″ when supply fluctuates between *SAS*′ and *SAS*″. Unlike the case of demand shocks, it is no longer possible to stabilise output *and* inflation.

When supply is high, at *SAS*′, the only way to stop inflation falling is to boost aggregate demand by cutting interest rates. Output is high when supply is high. Conversely, when supply is low as *SAS*″, to stop inflation rising it is necessary to cut aggregate demand by raising interest rates.

Similarly, it is possible to stabilize output completely but only at the cost of allowing big fluctuations in inflation. The *MDS* schedule is then vertical at potential output. A rise in short-run supply to *SAS*′ induces a big rise in interest rates to reduce aggregate demand to *Y** again. With high supply but low demand, inflation is temporarily low (relative to inherited wage growth) and firms wish to supply only *Y**. When supply shrinks temporarily to *SAS*″, firms supply output *Y** only if inflation is high (relative to inherited wage growth), which needs a low interest rate to boost demand.

Trade-offs in monetary objectives

Facing supply shocks, Figure 25–9 implies that it is a bad idea either to stabilise inflation completely at π* (which induces big fluctuations in output) or to stabilize output at *Y** (which induces big fluctuations in inflation). The macroeconomic demand schedule *MDS* in Figure 25–9 is a particular compromise in the way interest rates are set.

Any *MDS* schedule through point *E* achieves the targets π* and *Y** on average. The particular schedule *MDS* in Figure 25–9 makes the economy fluctuate between *A* (when supply is *SAS*″) and *B* (when supply is *SAS*′). This achieves acceptable fluctuations in both output and prices. A steeper *MDS* schedule, still through A, induces lower output fluctuations but larger inflation fluctuations. A flatter schedule has the opposite effect. The steepness of the schedule reflects the relative weight the central bank places on stabilizing inflation and output.

This trade-off does not arise for demand shocks. Figure 25–8 showed that, by fully offsetting demand shocks, the central bank stabilizes both output and prices. In reality, the central bank faces both supply and demand shocks, and cannot always diagnose which is which. It much choose a monetary rule that gives reasonable answers under both kinds of shocks.

The Taylor rule When rapid diagnosis of shocks is difficult, monetary policy steers a middle course between what is required by demand shocks and supply shocks. In so doing, interest rates react to deviations of both output and inflation from their long-run levels. This is exactly what is accomplished by setting interest rates according to a Taylor rule. Recall from Equation (1) that this implies that real interest rates *i* obey

$$i - i^* = a(\pi - \pi^*) + b(Y - Y^*) \quad a > 0, b > 0 \qquad (1')$$

Empirically, almost every central bank's behaviour can be represented as a Taylor rule. Now you understand why. It is a smart response when facing both supply and demand shocks.

Flexible inflation targeting

Interestingly, however, many central banks do not admit to following a Taylor rule. Moreover, many central banks have been given operational independence from government interference in the setting of interest rates *provided* they pursue *inflation targets* π^* chosen by the government.

The US Federal Reserve is explicitly charged with stabilizing *both* inflation and output. Most other central banks have been told by governments to make price stability their main concern. Only if this is being achieved, within some acceptable range, can central banks also think about output stability. Looking after output as well is the aim that dare not speak its name. Yet, empirically, central banks act as if they care about output too. Why not openly acknowledge it?

There are four possible answers. One is that the *long-run* inability to affect output should somehow make it also a subsidiary goal of monetary policy in the short run. Another is that admitting to caring about output would somehow jeopardize the central bank's ability to fight inflation. We discuss credibility in the next chapter.

A third is that we are pretty ignorant about trends in potential output, which is not directly observable. If inflation tends to rise when actual output exceeds potential output, and to fall when actual output is below potential output, it may be better just to target inflation since that at least can be measured. This argument has some force if central banks are to be held accountable for their behaviour. The next chapter also examines inflation dynamics in more detail.

A fourth answer is that flexible inflation targeting still allows a temporary role for output stabilization. What is flexible is not the eventual commitment to hit the target but how quickly that target is achieved.

Flexible inflation targeting commits a central bank to hit inflation targets in the medium run, but gives it some discretion about *how quickly* to hit its inflation target.

There is no conflict between output stability and inflation stability when shocks are demand shocks. It makes sense to try to hit the target as quickly as possible. Similarly, a permanent supply shock requires a permanent change in demand, which there is little reason to postpone. However, facing a *temporary supply shock*, Figure 25–9 showed that it makes sense temporarily to allow inflation to deviate from its target in order to mitigate the shock to output. Flexible inflation targeting allows such temporary departures, and hence allows some output stabilization, more than would be allowed by a stricter short-run adherence to inflation targets.

The steeper the *MDS* schedule chosen by the central bank, the larger the initial inflation response to a supply shock, but the more output is stabilized. Thereafter, the deviation of output from potential output affects nominal wage growth and gradually shifts the short-run supply curve back to its average position, until a new shock comes along. The steepness of the *MDS* schedule thus determines the size of the (temporary) effect on inflation, and thus the time before inflation returns to its long-run target. Smaller output fluctuations not merely mean larger initial shocks to inflation, but also less subsequent pressure on wages to adjust.

The key to successful flexible inflation targeting is that any concerns about output stabilization lead only to *temporary* changes in inflation and interest rates. Credible central banks can partially offset a shock today while promising to reverse this change in interest rates once the temporary shock is over. With no medium-run boost to demand, there is no reason for people to fear inflation in the medium run.

In contrast, weak central banks that lack credibility may cause panic by easing monetary policy today. People worry that they will not be tough enough later to reverse this demand expansion. Foreseeing sustained expansion, inflation gets going. This insight places credibility centre stage, where it belongs. Chapter 26 examines the economics of credibility and its effect on inflation.

SUMMARY

- The **classical model** of macroeconomics assumes full flexibility of wages and prices, and no money illusion.
- The **macroeconomic demand schedule** shows combinations of inflation and output at which planned spending on goods equals actual output when the money market is also in equilibrium. The schedule slopes down. For a given Taylor rule, lower inflation lets the central bank cut real interest rates, raising aggregate demand.
- In the classical model, there is always full employment. The **aggregate supply schedule** is vertical at **potential output**. The **equilibrium inflation rate** is determined by the intersection of the aggregate supply schedule and the macroeconomic demand schedule. The markets for goods, money, and labour, are all in equilibrium.
- In this model, fiscal expansion cannot increase output. To continue to hit its inflation target, the central bank must raise real interest rates to restore aggregate demand to the level of potential output. **Higher government spending crowds out an equal amount of private spending**, leaving demand and output unaltered.
- Changing the target inflation rate leads to an equivalent change in the growth of wages and nominal money in the classical model, but not to a change in output.
- **Supply-side economics** examines how to raise potential output by providing better incentives to suppliers of inputs or output.
- In practice, wages adjust slowly to shocks since job arrangements are long term. Short-run variations in labour input are met chiefly by changing hours. Only in the longer run is the number of workers adjusted, since this is more costly.
- **Wage adjustment** is sluggish not merely because wage bargaining is infrequent, but because workers prefer their long-term employers to smooth wages.
- Prices are based chiefly on labour costs. The **short-run aggregate supply schedule** shows firms' desired output, given the inherited growth of nominal wages. Output is temporarily responsive to inflation, since wages are already determined. As wage adjustment occurs, the short-run supply schedule shifts.
- The **Keynesian model** is a good guide to short-term behaviour but the **classical model** describes behaviour in the long run.
- Permanent supply shocks alter potential output. Temporary supply shocks merely alter the short-run supply curve for a while.
- If its effects were instant, monetary policy could completely offset **demand shocks**, stabilizing both inflation and output. **Temporary supply shocks** force a trade-off between output stability and inflation stability. The output effect of a **permanent supply shocks** can't be escaped indefinitely.
- **Taylor rules** view the central bank as setting interest rates in response to deviations of both prices and output from target. Realistic Taylor rules generate a downsloping *MDS* schedule.
- **Flexible inflation targeting** gives the central bank some scope about how quickly to hit its inflation target, and hence allows scope for temporary action to cushion output fluctuations. If such action today will credibly be reversed later, temporary management of demand need not have significant inflation consequences in the medium run.

Review questions

1 (a) Define the macroeconomic demand schedule. (b) How does a fiscal expansion affect the schedule under a given Taylor rule? (c) How would the central bank have to change monetary policy to hit its given inflation target in the long run?

2 Suppose opportunities for investing in high tech applications boost aggregate demand in the short run, but aggregate supply in the long run. Using AS and MDS schedules, show why output might rise *without* much inflation.

3 How do the following affect the short-run supply schedule, and hence output and inflation in the short run: (a) a higher tax rate? (b) higher labour productivity?

4 An economy has the choice of having half its workers make annual wage agreements every January, and the other half make annual wage agreements every July, or instead forcing everyone to make their annual agreement on 1 July. Which system is likely to induce greater wage flexibility (a) during a period of a few months? (b) during a period of several years?

5 OPEC raises the price of oil for a year but then a new supply of oil from Russia bids oil prices back down again. Contrast the evolution of the economy if monetary follows (a) a fixed interest rate? (b) a Taylor rule? (c) flexible inflation targeting? (d) a nominal money target.

6 ***Common fallacies*** Why are these statements wrong? (a) Fiscal expansion can increase output for ever. (b) Higher inflation always reduces output.