2 The supply side

2.1 Overview

2.1.1 Unemployment

Unemployment is a characteristic feature of a market economy. There are unemployed people looking for work who would be prepared to take a job at the going wage but cannot get a job offer. This is involuntary unemployment and it reflects the fact that the labour market does not clear.

Figure 2.1 illustrates how unemployment varies over time and across countries. We can see that there is a large amount of heterogeneity in unemployment across the developed economies in the figure; following the global financial crisis, average unemployment between 2009 and 2012 ranged from 4.5% in the Netherlands to 21.2% in Spain. In addition, the figure highlights that an individual country can experience large changes in unemployment over time; Irish unemployment fell from 16% in the late 1980s to just above 4% in the early 2000s, before rising again to 14% in the wake of the economic crises of 2009–12.

Unemployment is costly to the economy since it represents a waste of resources, and it is associated with unhappiness and psychological distress to those affected. It is a major source of concern for policy makers.

In this chapter, we develop the supply side of the macroeconomic framework to provide a model of unemployment. Whereas the demand side refers to spending decisions, the supply side refers to production activities in the economy. Although both capital and labour are inputs to the production process, we concentrate on the input of labour. The supply side refers to both the supply of labour by workers and the demand for labour by firms. We return to discuss capital accumulation when we look at long-run growth in Chapter 8. On the supply side, we ask how firms decide how much output to produce, how many workers to employ and what prices to set. We want to know about decisions to work and how wages are set.

2.1.2 Why the labour market does not clear

When a market clears, the price is such that there is neither excess supply of, nor demand for, the good. If the market is for 'labour', then the wage would rise in response to excess demand and fall in response to excess supply, with the result that there would be no 'unsold' labour. As we shall see, this is not a good way of thinking about the labour market. The data in Fig. 2.1 covers many countries over more than five decades. It reveals unemployment as

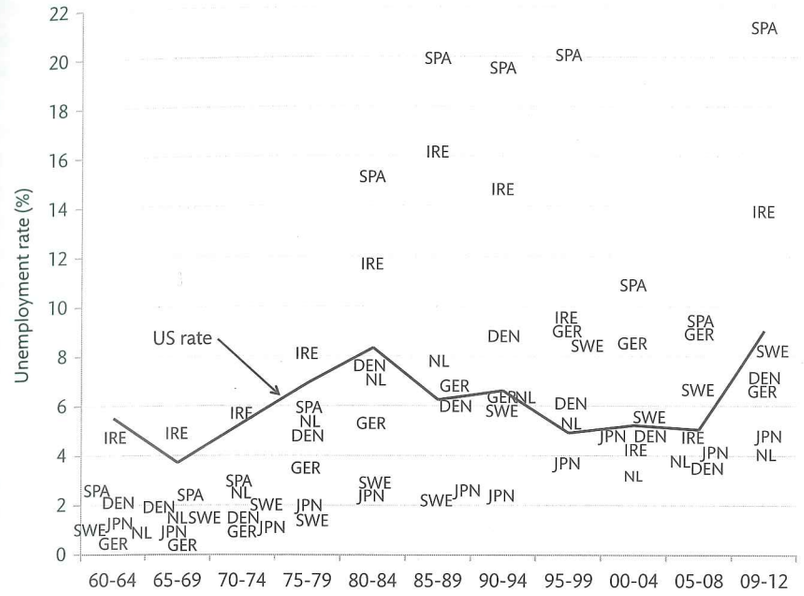

Figure 2.1 Trends and heterogeneity in unemployment for selected OECD economies, 1960–2012.

Source: Howell et al. (2007), Fig. 1.1, p. 10. Updated to 2012 using OECD harmonized unemployment rates.

characteristic of capitalist economies. The general case is one in which there are workers who are willing to work at the going wage but cannot find a job. Consistent with the phenomenon of involuntary unemployment is the large amount of evidence that workers are unhappy when they are unemployed. For example, in an early study, Clark and Oswald (1994) use data for a sample of six thousand British workers in 1991 and find that the unemployed have twice the level of mental distress of the employed.[1]

To understand why the labour market does not clear, we ask the obvious question of why an employer would not offer a job to a worker who is willing to work at a lower wage. One answer is that to be useful to an employer, a worker has to exert effort on the job and when the employer hires the worker at an hourly wage or a monthly or annual salary, she cannot pin down the supply of labour effort. Moreover, she cannot easily observe the effort the worker is making. The way the employer creates an incentive for the worker to work conscientiously is to create a cost to the worker of losing his job. When the employer chooses to set the wage above the level at which a worker would be prepared to take a job, the employee knows that if he loses his job he runs the risk of being unemployed. This makes him work effectively enough to keep his job. The term *efficiency wage setting* is used to describe this aspect of the supply side of the economy.

Thinking of the labour market in this way highlights two key factors that will influence the wage the employer sets.

[1] For a review of the literature on unemployment and happiness, see Oswald (1997).

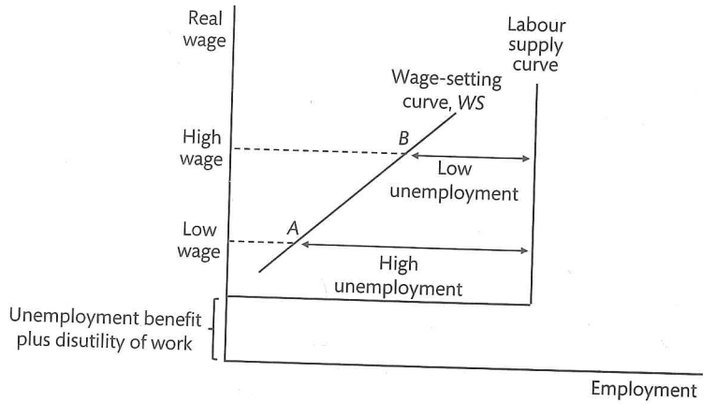

Figure 2.2 The wage-setting curve, *WS*.

1. First, is the income available to the worker if he is unemployed. If the alternative to working is claiming unemployment benefit and assuming there is a disutility associated with working, the utility the worker gets from working and receiving the wage must be higher than the utility from the alternative of not working and receiving unemployment benefit.
2. Second, the employer will have to offer a higher wage when the probability of the worker getting another job is higher: the wage she sets will rise as the economy-wide unemployment rate falls.

Figure 2.2 is a diagram with employment on the horizontal axis and the real wage on the vertical axis. The wage-setting curve is upward sloping. To get the worker to work hard, the wage is set above what the worker gets if he is not working (the unemployment benefit) plus the disutility of turning up to work, and it rises as unemployment falls. At point *A*, unemployment is high and a low wage is set: the cost of job loss is relatively high. At point *B*, unemployment is low. Given the relatively low cost of job loss, a higher wage is set.

A rise in the unemployment benefit will shift the wage-setting curve upwards and vice versa.

The labour supply curve is inverse-L shaped. The wage has to be above the unemployment benefit plus the disutility of work for workers to be willing to work effectively. The vertical portion of the labour supply curve is a simplification. Two factors lie behind a steep or 'inelastic' labour supply curve at the level of the economy as a whole. For workers who are already working, a rise in the wage has both an income and a substitution effect. The substitution effect suggests that labour supply rises with the wage because working becomes more worthwhile. The income effect suggests the opposite: since it is assumed that there is a disutility of working, if the same income can be earned from fewer hours of work, labour supply will fall. It is even possible for the labour supply curve to be backward bending if the income effect outweighs the substitution effect. The second factor concerns the decision to participate in the labour market. As the wage increases, participation goes up. There will be a steep labour supply curve if the tendency of workers to enter the labour force when the wage goes up is offset by a fall in hours of work by those who are working.

A point on the wage-setting curve is an answer to the question: what wage has to be paid to secure adequate worker effort (effective labour input) at a given level of unemployment (and associated level of employment)?

A point on the labour supply curve is an answer to the question: if a given wage were to be offered, how much labour would workers be willing to supply?

The horizontal gap between the wage curve and the labour supply curve is therefore involuntary unemployment, because it shows the extra supply of labour that would be offered at that wage but is not employed when wages are set on the wage-setting curve. The vertical gap between the wage-setting curve and the horizontal part of the labour supply curve is inversely related to the cost of job loss at the relevant level of employment: a higher efficiency wage has to be paid when the labour market is tight and it is relatively easy to get another job.

The efficiency wage explanation of why the labour market does not clear is based on the nature of the relationship between employer and worker.[2] Using the language of micro-economics, the special features of labour make it impossible to write a complete contract for the supply of labour in the same way that a contract can be written for the supply of energy or other inputs to the production process. The employer cannot specify in a contract every aspect of the work she requires of the worker and she is unable to perfectly monitor his output. Since worker effort is essential to the employer, it is the wage-setting curve and not the labour supply curve that is relevant for how wages in the economy are set, and, as we shall see, for pinning down the unemployment rate consistent with constant inflation. The outcome is that involuntary unemployment is characteristic of the economy.

It might be suggested that the employer use piece rates rather than an hourly wage to pay workers. By paying for the worker's output rather than the worker's time, the problem of not being able to observe effort is solved. But taking a look at any economy quickly reveals that very little economic activity is organized around piece rates for labour. This is particularly true of modern service-based economies, where output is less easily quantifiable. In addition, much of the production activity in the economy is based on team production, where the contribution of an individual worker is hard to determine.

2.1.3 Supply side effects on unemployment

The supply side effects on unemployment relate to both the labour supply and labour demand parts of the economy. The wage-setting curve relates to the *supply of labour* and shows that the real wage that has to be paid to workers rises as employment rises and lies above the labour supply curve. This curve shows the *wage-setting real wage*. This is positively sloped for the efficiency wage reasons explained in the previous subsection. In the modelling section, we discuss a number of other explanations for the wage-setting curve. One of these relates to the case where workers have market power. If the wage is set by a union, then the union can set wages above the efficiency wage. In this case, the wage-setting curve would be above the one that applies in the absence of unions.

[2] The efficiency wage model was first formalized in Shapiro and Stiglitz' landmark 1984 paper *Equilibrium Unemployment as a Worker Discipline Device.*

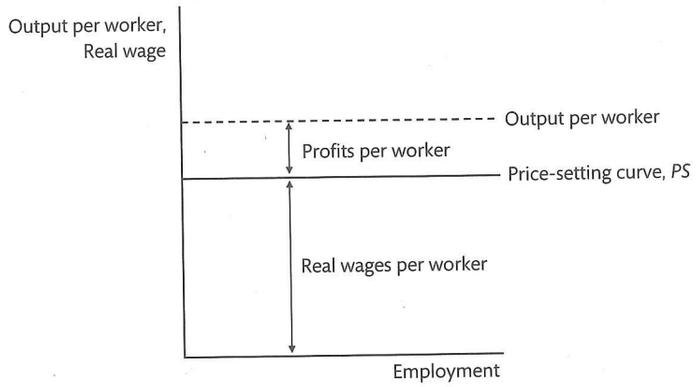

Figure 2.3 The price-setting curve, *PS*.

The other side of the labour market reflects the *demand for labour* by imperfectly competitive firms. This defines a second real wage: this is the real wage that makes production (and hence, the employment of workers) profitable for the price-setting firm. This curve shows the *price-setting real wage*.

As our baseline case, we use a simple model of labour demand where there is a constant real wage at which price-setting firms find it profitable to employ workers. In the modelling section, we derive the price-setting real wage from the firm's pricing decision. Here we focus on the outcome. We assume that the firm's production function is very simple: labour is the only input, and productivity, which is output per worker, is constant. In order to produce, the firm requires a fixed profit margin and this implies the real wage at which it finds it profitable to employ workers. Given these assumptions, the price setting real wage curve is flat (see Fig. 2.3). As shown in the diagram, output per worker is divided into two chunks: profit per worker and the real wage.

Figure 2.4 shows the wage-setting and price-setting curves. The intersection of the price-setting (*PS*) curve and the upward-sloping wage-setting (*WS*) curve determines the real wage, employment and unemployment when the supply side is in equilibrium. The intersection of

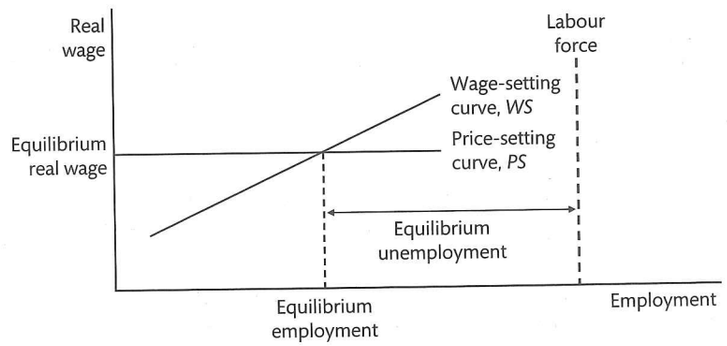

Figure 2.4 Supply-side equilibrium: the intersection of the wage-setting and price-setting curves.

the wage- and price-setting curves fixes the equilibrium real wage and employment level. At the equilibrium, the real wage is consistent with what is needed to secure sufficient labour (on the *WS* curve) and for production to be profitable (on the *PS* curve).

We can use Fig. 2.4 to show how the unemployment rate is defined. The labour force is shown by a vertical line. This is the total number of people reported by the statistical agency who are working or looking for work. The unemployment rate is defined as unemployment divided by the sum of employment and unemployment, that is, the numbers unemployed divided by the labour force:

$$\text{Unemployment rate} \equiv \frac{\text{unemployed}}{\text{employed} + \text{unemployed}} \equiv \frac{\text{unemployed}}{\text{labour force}}.$$

Equilibrium unemployment is the difference between employment at the *WS* – *PS* intersection and the labour force. From Fig. 2.5, it is clear that equilibrium unemployment will rise if the wage-setting curve shifts up or if the price-setting curve shifts down. Taking the case of a higher unemployment benefit first, we have already seen that a higher unemployment benefit will shift the *WS* curve up. In Fig. 2.5a, this shifts the *WS* curve up to *WS*′. The new *WS* – *PS* intersection is at a lower level of employment. The economics behind this can be explained as follows. For equilibrium, the real wage has to be on the *PS* curve; otherwise firms will not be prepared to produce output. An increase in unemployment benefits reduces the cost of job loss, which shifts the *WS* curve upwards. In order that the real wage on the wage-setting curve is brought down into line with the *PS* curve, it is necessary for unemployment to be higher. Given the higher out-of-work benefits, a higher risk of job loss (which is associated with higher unemployment) is necessary to make an unchanged real wage consistent with wage setters' behaviour.

Equilibrium unemployment will also be higher if the *PS* curve shifts down (from *PS* to *PS*′ in Fig. 2.5b). If there is a reduction in the extent of competition in the goods market, which allows the mark-up of price over unit labour costs to rise, the price-setting real wage will be reduced: under the new conditions, firms will only produce if the real wage is lower. In terms of Fig. 2.3, a higher mark-up increases the share of output per worker that goes to profits

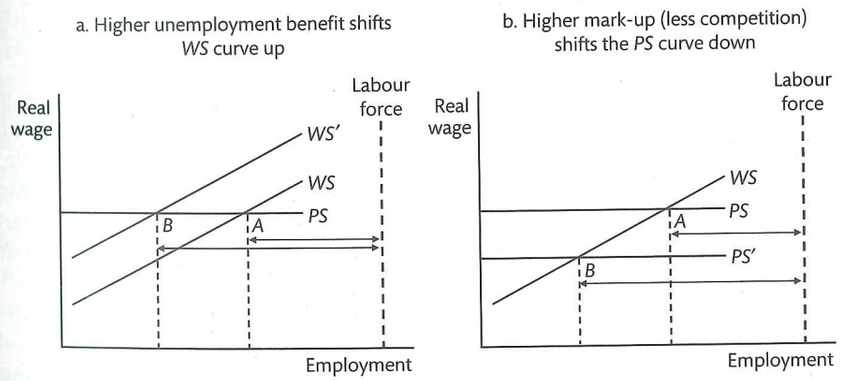

Figure 2.5 The impact on equilibrium unemployment of shifts in the *WS* and *PS* curves.

Note: the double-headed arrows show equilibrium unemployment for each case.

and reduces the share to wages, and hence, the real wage. The new equilibrium is at a lower real wage and higher unemployment. For the wage-setting real wage to be reduced to the new equilibrium level, there must be higher unemployment in the economy. With a higher cost of job loss, the efficiency real wage is lower.

The concept of equilibrium unemployment is a medium to long-run concept. It tells us the unemployment rate at which both wage and price setters are content with the prevailing real wage. The kinds of policies that can be implemented to affect equilibrium unemployment are those that shift the *WS* or the *PS* curve. These are *supply-side policies*.

In the modelling section and in Chapter 15 on supply-side policies, we enrich the model of the supply side by introducing additional institutions and policies that shift the wage- and price-setting curves. A more detailed examination of both institutions and policies is presented in Chapter 15. These include the role of unions, taxes, workplace policies that affect the disutility of exerting effort, labour and product market regulations, and competition policy. These factors help explain both the cross-country variation and the changes over time in the 5-year average unemployment rates shown in Fig. 2.1.

2.1.4 Nominal rigidities and demand-side policy

When discussing equilibrium unemployment, the focus is on the medium run when the economy is at a *WS* – *PS* intersection, and hence on the effect of supply-side policies and institutions on unemployment. In this subsection, we introduce *nominal rigidities* and the role of *demand-side* policies. The term nominal rigidity refers to the fact that nominal wages (in dollars or euros) and prices do not adjust immediately to fluctuations in aggregate demand to keep the economy at equilibrium unemployment.

In Chapter 1, we assumed an extreme form of this rigidity, namely that prices and wages don't change at all in response to shifts in demand. This meant that when aggregate demand shifted, as a result, for example of an investment boom, output and employment in the economy responded fully to bring supply into line with the higher demand. We used the multiplier process to model the response of output and employment based on the assumption that wages and prices remained unchanged. An alternative extreme assumption is that the economy is always at the medium-run equilibrium, i.e. at a *WS*/*PS* intersection, and therefore that fluctuations in aggregate demand do not affect output and employment. The terms 'fixed price' and 'flex price' are sometimes used to label these two extreme cases.

In building a model suitable for analysing real-world economies, we need a model that is neither 'fixed price' nor 'flex price'. The model we set out includes nominal rigidities but wages and prices are not completely fixed. Wages are changed at intervals, for example, at an annual wage review. Nominal rigidities characterize both wage and price setting. More detailed arguments and evidence are provided in the modelling section. Here we summarize the main points. Before doing so, it is important to distinguish between real and nominal wages.

Nominal wages, real wages and inflation

To this point, all of the discussion about the supply side has been in terms of the *real* wage. This is because it is the real wage that workers care about (i.e. how much their dollar or euro wage buys in goods and services) and therefore, that the employer has to be concerned with

when setting the wage to secure the worker's effort. From the labour demand side, it is the cost of labour in terms of the price they get for their output that firms care about. However, workers are paid a wage in money terms: this is the *nominal* wage and firms set prices.

We can see how real and nominal wages are related in the model as follows. Given the unemployment rate, employers (or unions if they are setting wages) set the nominal wage so as to achieve their desired real wage on the wage setting curve. This means they must make an assumption about the *consumer price level* when they set the nominal wage. Similarly, firms set their *product price* making an assumption about the nominal wage to achieve the price-setting real wage on the *PS* curve. The consumer price level is the outcome of price-setting by firms across the economy.

Note that when wages are set by the employer, it would be the firm's human resources division that sets the nominal wage taking account of the consumer price level to ensure workers supply adequate effort for the firm's operations. Given the nominal wage, the marketing and strategy divisions set the price for the firm's product.

Modern economies are typically characterized by a positive rate of inflation. Central banks often target an inflation rate of 2%. If nominal wages rise by 2% per annum and prices rise by 2% per annum, the real wage is unchanged. At a *WS* – *PS* intersection, the real wage is constant, which means nominal wages and prices are rising at the same rate. This is a constant inflation equilibrium.

Rigidities in wage setting

Nominal wages are set periodically, usually at an annual wage round or review. They are not continuously adjusted by the wage setter. Barattieri et al. (2010) analyse US survey data and find that wages are indeed very 'sticky'; they are most likely to be adjusted just once every year. The authors also find that there is little variation in the frequency of wage changes across different industries and occupations.

An important reason for the stickiness of wages relates to the interactions between employers and workers, where considerations of fairness and morale play an important role. Campbell and Kamlani (1997) surveyed 184 firms and find strong support for two explanations of wage rigidity (in this case, why wages are not cut as much as possible in a recession). First, firms were concerned that wage cuts would lead their most productive workers to quit, whereas layoffs could target the least productive workers. Second, respondents linked wage cuts to reduced worker effort, particularly when wage cuts were viewed as being 'unfair'. Bewley (2007) reviews the empirical literature on fairness and wage rigidity and finds that fairness is one of the primary determinants of company morale. He also finds that wage cuts are only viewed as being fair when they are seen as saving a large number of jobs.

Rigidities in price setting

The frequency of price changes varies a great deal across industries. However, for large parts of the economy, firms are cautious about frequent price adjustments in response to fluctuations in demand because of their concern about their competitors' and customers' reactions.

A detailed survey of how firms set prices using a structured questionnaire of a random sample of 330 US firms found that almost half of all prices were changed no more than

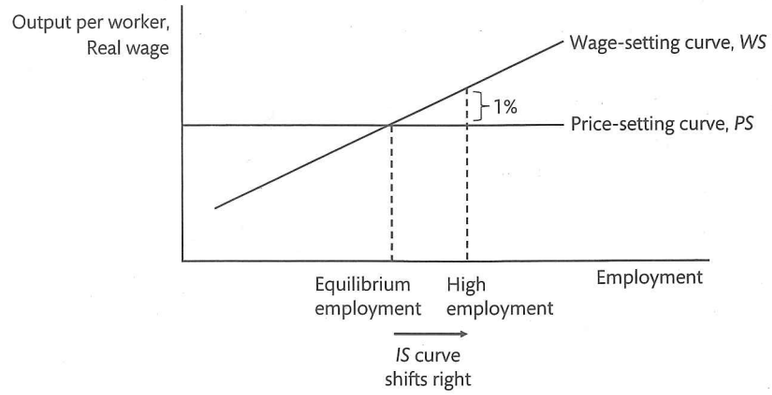

Figure 2.6 The response of wages and prices to a cyclical upswing.

annually. The survey identified the following major reasons for price stickiness: firms are deterred from raising prices because of concerns their competitors will not follow suit; cost increases are generally industry-wide and can serve as convenient signals that other firms are probably under pressure to raise prices; implicit contracts with customers deter price hikes when demand rises but permit them when costs rise; and firms hold prices steady until the next regularly scheduled price review.[3]

Aggregate demand shocks and the role of nominal rigidities

In the macroeconomic model, we make simplifying assumptions about how wage and price rigidities operate. The simplifying assumptions reflect the arguments presented about why wages and prices are adjusted infrequently. We assume that wage contracts are reviewed annually at the 'wage round'. This means that if an aggregate demand shock occurs in the interval between wage rounds, the wage is not adjusted. We assume that prices are not adjusted in response to shifts in aggregate demand; however, prices are adjusted immediately following the wage round. Since the adjustment in wages will reflect changes in aggregate demand, prices respond to changes in aggregate demand with a lag.

The timeline for wage and price setting, shocks and changes in output and employment can be summarized as follows:

Aggregate demand shock → output and employment change
Next wage round → nominal wages change
Immediately after the wage round → prices change

Before looking at an aggregate demand shock, we look at what happens when the economy is at supply-side equilibrium in an environment of constant inflation. The equilibrium is where the *WS* and *PS* curves intersect in Fig. 2.6. Inflation in the previous year was 2%.

At the next annual wage round, wage setters observe that prices have risen 2% over the previous year and they will set a 2% nominal wage increase to keep the real wage constant.

[3] See Blinder et al. (1998).

After the wage round, firms will observe that the 2% increase in wages has increased their costs by 2%. If they raise their prices by 2%, this will keep their profit margin constant (the real wage will remain on the *PS* curve). As long as the economy remains at the equilibrium level of employment, wage and price inflation will remain unchanged at 2% per year and the real wage will remain constant.

We now look at what happens when there is an aggregate demand shock of the kind discussed in Chapter 1: for example, an investment boom raises output. Since the investment boom does not affect the *WS* or the *PS* curve, it has no effect on equilibrium unemployment. The investment boom raises output and employment in the short run: we assume output per worker is constant. As Fig. 2.6 shows, the economy is no longer in medium-run equilibrium.

What happens the next time there is an opportunity for wages to be adjusted? At the next wage round, employment is higher and wage setters will respond by setting a nominal wage increase to take the real wage up to the point on the *WS* curve at the higher level of employment. They will need a 2% nominal wage increase as usual, plus an additional increase. In the example shown in Fig. 2.6, this is an extra 1%. Nominal wages go up by 3%. How do price setters respond to the higher wages? Their costs have risen by 3% (rather than the usual 2%), so they mark up this cost increase in their prices and price inflation goes up from 2% to 3%. Firms are likely to feel comfortable about raising their prices at this point, because they can observe that wages have gone up during the annual wage round for their competitors as well. We have the result that an expansion of aggregate demand that pushes output and employment above the equilibrium level is followed by a rise in wage and price inflation.

To summarize, when the economy is at equilibrium unemployment, inflation is constant. A demand shock will shift the economy away from equilibrium because wages and prices do not adjust instantly to keep the economy at equilibrium. Instead, output and employment respond to the change in aggregate demand. In the example of an investment boom, this leads to a fall in unemployment and a rise in inflation. More generally, a positive demand shock leads to a movement away from equilibrium with higher employment and a rise in inflation; a negative demand shock leads to lower employment and lower inflation.

This behaviour of the economy, which is called an upswing or downswing of the *business cycle*, creates a role for a policy maker who aims to improve welfare by keeping the economy close to the medium-run equilibrium unemployment rate. The involuntary unemployment characteristic of the economy when it is at the constant inflation equilibrium (i.e. *WS* – *PS* intersection) is raised in a business cycle downswing and lowered in an upswing. A policy maker who focuses on stabilization and uses demand side policy is introduced in Chapter 3.

2.1.5 Facts about the supply side

Efficiency wage setting

There is a large body of empirical evidence documenting the existence of a 'wage curve', which is represented in the model by the *WS* curve.[4] Microeconomic data on local labour

[4] For an introduction to the empirical literature on using microeconomic evidence to estimate wage curves, see Blanchflower and Oswald (1995).

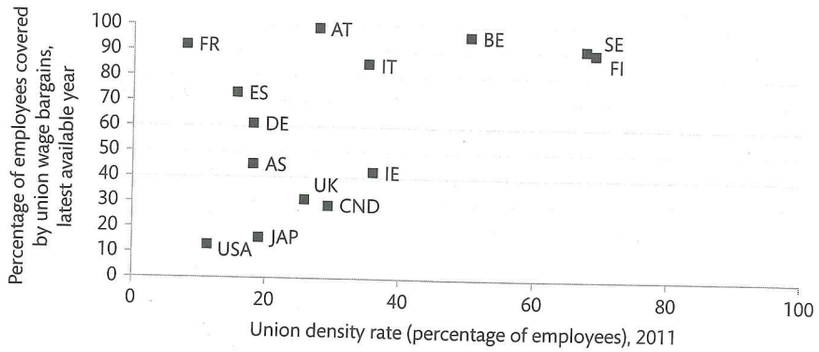

Figure 2.7 The importance of unions in wage setting: selected OECD countries.

Source: Jelle Visser, Amsterdam Institute for Advanced Labour Studies AIAS, ICTWSS Database Version 4 (April 2013). AS Australia, AT Austria, BE Belgium, CND Canada, DE Germany, ES Spain, FI Finland, FR France, IE Ireland, IT Italy, JA Japan, SE Sweden. See footnote 8.

markets is used to uncover the relationship between a change in the unemployment rate at the local level and the wage that is paid. A comprehensive meta-study of more than 200 estimates from a large number of countries points toward the existence of a wage curve with an elasticity of -0.07. This means that a 10% rise in the unemployment rate (for example, an increase in the rate of unemployment from 10% to 11%) would, holding everything else constant, lead to a fall in the real wage of 0.7%.[5]

A vivid example of efficiency wage setting from the early years of mass manufacturing in the US is documented by Raff and Summers (1987): this is Henry Ford's introduction of a $5 day for his production workers in 1914. This represented a 240% pay increase for workers at his plant. Worker turnover fell from 370% in 1913 to only 16% in 1915 and absenteeism was reduced from 10% to 2.5% in just one year.[6] The authors conclude that in this case, wage increases resulted in significant productivity benefits and higher profits.

It is important to understand that the increase in pay was not a response to labour shortage. On the contrary, there were queues of workers wanting to work in the factory and yet instead of allowing the wage to fall to 'clear the market', Ford did the opposite, raising wages substantially.[7] This is taken as a famous illustration of the payment of efficiency wages. As will be discussed further in Chapter 15, efficiency wages appear to be intrinsic to the labour market, even in emerging economies that rely on cheap labour, such as China.

Union wage setting

In many economies, unions play a central role in wage setting, as shown by Fig. 2.7. In some European countries, wages set by unions cover virtually the entire workforce (e.g. 99% in Austria). In the US, by contrast, only 13% of workers are covered. In general, we can think of

[5] See Nijkamp and Poot (2005).

[6] Turnover is measured as the total amount of workers hired in a year divided by the average workforce for that year. For example, Ford had to hire 50,448 workers in 1913 to maintain an average workforce of just 13,623. This equates to annual turnover of 370%. All figures from Raff and Summers (1987).

[7] See Raff and Summers (1987).

the labour market comprising two parts: a unionized sector and a non-unonized sector. In the latter, wages are not covered by union agreements and employers set efficiency wages; in the unionized sector, wages are set by unions. When unions set wages, they can use their bargaining power to set the wage above the efficiency wage. In the model, this implies a higher *WS* curve.

The variation in the presence and organization of unions across countries is interesting because it gives a hint at one of the reasons unemployment rates may differ across countries for lengthy periods of time. In some countries, labour markets are highly unionized, in others they are not. Types of union bargaining vary widely. In some countries with very high coverage of the workforce by union wage bargains, unemployment is lower than the OECD average (e.g. in Austria and the Nordic countries) whereas in others, such as France or Italy, unemployment rates are relatively high.

This suggests that the answer to the question of the role of unions in unemployment is more complex than we might think at first. It turns out that in institutional situations where unions are powerful and recognize their influence on the whole economy, they tend to exercise bargaining restraint, which is compatible with low unemployment (a downward shift in the *WS* curve in the model). In other settings, powerful unions take a narrower perspective and do not exercise restraint. Their bargaining power allows them to set higher wages and the economy ends up with higher unemployment.

The importance of unions and collective bargaining in wage setting in OECD countries is demonstrated in Fig. 2.7.[8] The scatterplot shows union density, which is the proportion of wage and salary earners in employment who are union members, and bargaining (or union) coverage, which is the proportion of wage and salary earners who are covered by wage bargaining agreements. The latter measure accounts for the fact that wage bargaining agreements might implicitly stretch wider than those workers who are in unions. For example, the latest available data for France shows union density of just 8% but bargaining coverage of 92%.

The constant inflation rate of unemployment

Actual unemployment will deviate from the equilibrium rate of unemployment over the economic cycle as a result of fluctuations in aggregate demand, for example due to shifts in the *IS* curve as discussed in Chapter 1. In Fig. 2.8, we show actual unemployment rates and estimates made by the OECD of constant inflation unemployment rates in four advanced economies.

The constant inflation or equilibrium rate of unemployment is sometimes called the NAIRU—the Non-Accelerating Inflation Rate of Unemployment. This is an estimate of the unemployment rate at which inflation would be constant. The figures show, as expected, that the NAIRU is much less volatile than actual unemployment in all four countries. Actual unemployment is measured in a comparable way across countries using labour market surveys (the so-called harmonized rate of unemployment published by the OECD).

[8] The variables used from database were UD and UD_s for union density and AdjCov for bargaining coverage. See AIAS website for detailed definitions. Union density data is for 2011 for all countries except France and Spain, where it is for 2010. Bargaining coverage is for the latest available year, which ranges between 2007 and 2011.

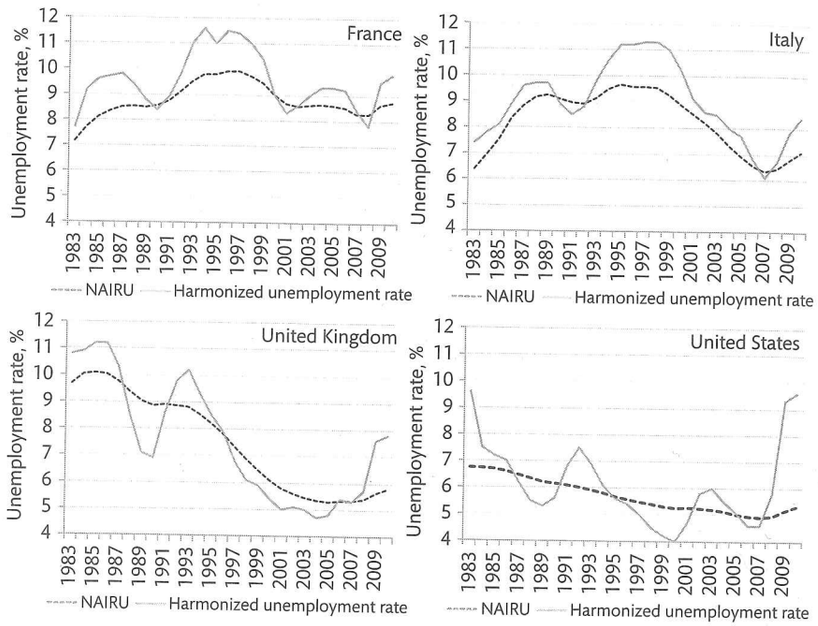

Figure 2.8 Non-Accelerating Inflation Rate of Unemployment (NAIRU) and harmonized unemployment rates in France, Italy, the United Kingdom and the United States: 1983–2010.

Source: OECD Economic Outlook (accessed December 2011).

Patterns of unemployment differed between the continental European economies (France and Italy) and the UK and US over this period. Unemployment rates in France and Italy were consistently above equilibrium, whereas there were periods when unemployment was both above and below equilibrium in the UK and the US.

Figure 2.8 also shows that actual and equilibrium unemployment were on average higher in these continental European economies than in the Anglo-Saxon ones over the period, with all countries excluding France experiencing a sustained drop in the equilibrium rate of unemployment from the mid nineties to the onset of the global financial crisis in 2008. In all four countries, actual unemployment rose dramatically during the global economic downturn and was slow to fall thereafter.

In Fig. 2.8, we saw that unemployment differs from equilibrium unemployment over the economic cycle. In the *WS – PS* model, when output is above equilibrium (i.e. when unemployment is below equilibrium), this creates upward inflationary pressure and vice versa.

Figure 2.9 displays the inflation rates in selected OECD countries from the 1960s to the present: whilst inflation in the past decade has been low at 2% to 3% in many of the OECD countries, it was much higher, and often at rates between 10% and 20% in the 1970s. By comparing Fig. 2.8 and Fig. 2.9, we can see that the decline in inflation in France and Italy from high rates at the end of the 1970s to very low rates in the mid 2000s is consistent with the persistence of unemployment above the estimated constant inflation rate during this period.

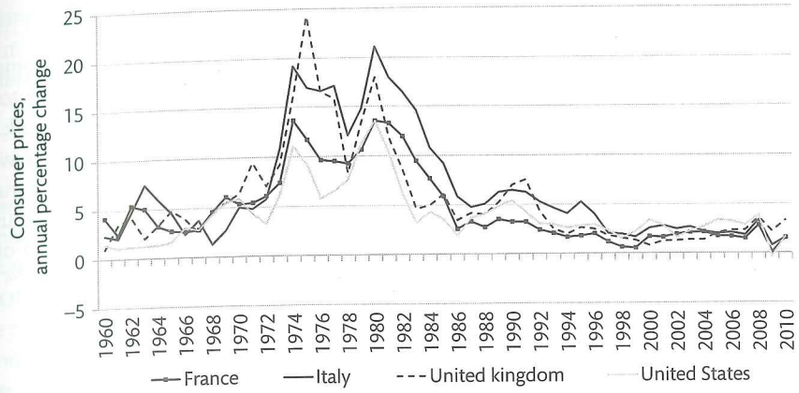

Figure 2.9 Consumer price inflation rates in France, Italy, the United Kingdom and the United States: 1960–2010.

Source: OECD Monthly Economic Indicators (accessed January 2012).

In Chapter 3, we look at the costs of getting inflation down from its high levels in the 1970s in terms of prolonged high unemployment. The years of so-called 'stagflation'—a combination of high unemployment and high inflation—imposed heavy costs on economies. As a consequence, policy makers sought to find better ways of managing the economy. One outcome was a move to inflation targeting and central bank independence.

2.2 Modelling

Following the distinction between the role played by real and nominal rigidities introduced in Section 2.1, we break down the modelling of the supply side in this section into two parts, each of which is focused on an important question.

1. Supply-side effects on unemployment. In Section 2.2.1, we shall look in more detail at the structural features of the economy that determine the medium-run equilibrium level of output and unemployment around which the economy fluctuates over the course of the business cycle.
2. Nominal rigidities, inflation and the business cycle. What happens when the economy is away from equilibrium—e.g. as a consequence of fluctuations in aggregate demand? In particular, what is the response of inflation? Answering this question in Section 2.2.2 involves extending the discussion of inflation from Section 2.1 and introducing Phillips curves.

In the applications section (2.3) at the end of the chapter, we show how we can combine the demand and supply sides to model the business cycle. Shocks to aggregate demand and to the supply side move the economy away from equilibrium. This leads us into Chapter 3, where we introduce the policy maker and show how policy intervention can stabilize the economy following a shock.

2.2.1 Supply side effects on unemployment

In Section 2.1, we begin with the fact that the employer cannot write and enforce a complete contract specifying work effort. Faced with this problem, the employer will *choose* to pay a wage that is higher than the wage at which the worker would be prepared to work. The implication is that there is involuntary unemployment in equilibrium. In the Appendix, we set out the textbook model of a perfectly competitive labour market where the labour market clears in equilibrium (we call this the hiring hall case). Some readers may find it is a useful reference point because it shows how the textbook model differs from the model of the supply side that we use in this book.

Incomplete employment contracts and price-setting firms

Since involuntary unemployment is a ubiquitous characteristic of market economies, this is a defining feature of the supply-side equilibrium in the macro model we are building. As we discuss in Section 2.1, wages will be set above the level at which a worker would supply labour. This defines the wage-setting curve. Facing downward-sloping demand curves for their products, firms set prices as a mark-up over their costs. This defines the price-setting curve. The real wage and equilibrium employment are the outcome of these wage- and price-setting decisions across the economy.

The labour supply side and wage setting

Efficiency wage setting means there must be a cost of job loss. At the prevailing real wage, say, w_0, additional workers would be prepared to work. However, they cannot bid down the wage because the employer knows that given the state of the labour market, unless w_0 is paid, the cost of job loss will not be high enough for workers to stay and work diligently.

The economics and management literatures stress a broad range of incentive problems faced by employers because of information problems in the labour market. In addition to the role of motivation that we have discussed, employers face problems of retention and recruitment.

Worker turnover is costly to employers. Workers move from job to job, from employment to unemployment (and vice versa) and also leave and enter the labour force. In the simple explanation of efficiency wages set out above, the worker either worked hard enough to be valuable to the employer or not. A richer model would include the employer's need to pay a wage that takes account of the costs she incurs due to turnover. The employer's optimal response to this is to raise the wage—it pays the employer to pay a higher wage in order to reduce turnover. Moreover, when unemployment is lower, it is easier for a worker to find another job and turnover will go up. This provides another explanation for the positively sloped wage-setting curve that is above the labour supply curve.

Similar arguments apply to recruitment. Recruitment in the real world is normally a difficult process, in which the firm has to compete against other firms to get the new hires it wants, and having unfilled vacancies is costly to the firm. In this case, it pays the employer to pay a higher wage in order to reduce the incidence of unfilled vacancies. A realistic assumption is that the proportion of its vacancies that it can fill depends positively on the wage it offers relative to its competitors and negatively on the tightness of the labour market.

Taking account of all of these considerations, the unemployment rate is therefore a key determinant of the 'wage-setting real wage', which lies above the labour supply curve.

In terms of nominal wages, and writing the wage setting equation in terms of employment, it is

$$W = P^E \cdot B(N, \boldsymbol{z}_w),$$

where P^E is the expected price level and B is a positive function of the level of employment, N, and a set of wage-push variables, $\boldsymbol{z}_w$. Whether wages are set by unions, employers, or through bargaining, it is the *nominal* (i.e. money) wage that is fixed. However, workers will evaluate wage offers in terms of the *real* wage it is expected to deliver—i.e. it is the nominal wage relative to the expected consumer price level that affects workers' standard of living and hence their utility.

The wage equation can be written in terms of real wages to define the upward-sloping wage-setting curve:

$$w^{WS} = \frac{W}{P^E} = B(N, \boldsymbol{z}_w). \qquad \text{(wage-setting real wage equation, } WS\text{)}$$

We set out a simple formal model of efficiency wage setting in Chapter 15. The basic diagram is shown in Fig. 2.10. The opportunity cost of taking a job consists of two elements: the unemployment benefit and the disutility of exerting effort when working. The wage on the wage-setting curve is above the opportunity cost of working and increases as the unemployment rate falls. As we shall see in Chapter 15, the equation for the wage-setting curve is non-linear: this is because as involuntary unemployment approaches zero, the cost of job loss goes toward zero and the wage that has to be paid to elicit effort goes toward infinity. Similarly, as the wage approaches the opportunity cost of working, it will not be possible to recruit labour. The figure highlights the presence of both voluntary and involuntary unemployment when the economy is at a medium-run equilibrium on the *WS* curve.

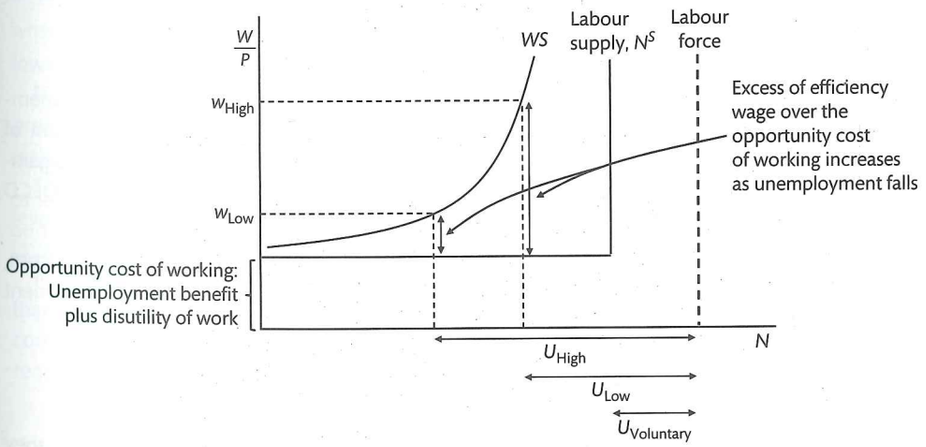

Figure 2.10 Efficiency wage setting.

To simplify the diagrams, we normally draw the *WS* curve as linear: it will be shifted by the unemployment benefit (Fig. 2.5a) and by the other wage push factors, z_w, including the effects of unions.

When workers have market power in the labour market, then the gap between the wage on the *WS* curve and the opportunity cost of working consists of:

1. the mark-up per worker (in real terms) that has to be paid in order to get the worker to exert effort and
2. any additional mark-up associated with worker bargaining power.

Workers can have bargaining power in the labour market because they have particular skills or because they are organized into unions. In unionized workplaces, wages are set through negotiations between the employer and the union. A simplified model of union wage-setting takes the case of the so-called monopoly union, where the union can unilaterally set the wage. The union sets the wage in the interests of its members, who are concerned with both the real wage and employment. It aims to strike a balance between (i) too high a wage, which will push up the price of the firm's product and decrease demand for the firm's output and hence reduce employment; and (ii) too low a wage, which will fail to use the union's monopoly power to secure better living standards over and above the efficiency wage. A model of union wage-setting is developed in Chapter 15.

Shifts in the WS *curve*

The wage-push factors in the wage-setting curve (the z_w's) include institutional, policy, structural and shock variables.

The *WS* curve shifts down, which reduces equilibrium unemployment, when:

1. There is a fall in the level of unemployment benefits or their duration. This raises the cost of job loss.
2. There is a fall in the disutility of effort. Improvements in working conditions shift the *WS* curve downwards because they increase the cost of job loss, reducing the wage that has to be paid to get workers to work effectively.
3. Unions are given less legal protection. This reduces the union mark-up.
4. Unions are weaker, for example as measured by a lower proportion of trade union members amongst employees (lower trade union density) or when a lower proportion of employees are covered by collective bargaining agreements (lower collective bargaining coverage). (We discuss the evolution of trade union density and coverage for OECD countries over the last 50 years in Chapter 15.)
5. Unions agree to exercise bargaining restraint in the context, for example, of a wage accord, because this lowers the real wage that is acceptable to unions at a given unemployment rate.

The labour demand side and price setting

In a textbook, perfectly competitive goods market, firms are price and wage-takers: they maximize profits by taking the market price, *P*, and setting it equal to their marginal cost:

$$\begin{aligned} P &= MC \\ &= \frac{W}{MPL} \\ \Rightarrow \frac{W}{P} &= MPL. \end{aligned}$$

The marginal product of labour (or labour demand) curve therefore shows the employment level a competitive firm will choose at a given real wage.

By contrast, firms facing downward-sloping demand curves *set a price* to maximize profits. The mark-up on marginal cost will depend on the elasticity of demand, which is the responsiveness of output demanded to a change in price. As the elasticity of demand rises, the mark-up falls until we get to the special case of perfect competition, where the elasticity of demand is infinite and the price is the one that clears the market.

When a firm faces a downward-sloping demand curve (and assuming for simplicity it does not behave strategically towards other firms), it maximizes profits when marginal revenue is equal to marginal cost. If the (absolute value of the) elasticity of demand (η, called eta) is constant, then there is a constant mark-up of ($\frac{1}{\eta-1} = \mu$) and we have the price-setting formula (derived in the Appendix):

$$P = \left(1 + \frac{1}{\eta - 1}\right)\left(\frac{W}{MPL}\right) \equiv (1 + \mu)\left(\frac{W}{MPL}\right). \qquad \text{(price-setting (mark-up) equation)}$$

For example, if the elasticity of demand is 8, $\mu = 0.14$, and the price is set at 14% above marginal cost. The Greek letter μ, mu, is pronounced 'mew'.

The next step is to derive the price-setting real wage from the price-setting equation:

$$\begin{aligned} \frac{W}{P} &= \frac{1}{(1+\mu)} MPL \qquad (2.1) \\ &= (1 - \mu)MPL, \qquad \text{(price-setting real wage)} \end{aligned}$$

where to simplify the equations, we use the approximation $\frac{1}{(1+\mu)} \approx (1 - \mu)$, which holds for low values of the mark-up, μ.[9]

Figure 2.11 illustrates the *PS* curve: the price-setting real wage is a fraction of the marginal product of labour. For the example of the elasticity of demand of 8, the price-setting real wage is 86% of the level of the marginal product of labour.

The excess of the real wage on the labour demand curve above that on the *PS* curve at any level of employment is the supernormal profits per worker (in real terms) associated with imperfect competition in the product market.

For simplicity in working with the macro model, we normally use a horizontal rather than a downward-sloping *PS* curve. As we have seen, switching from perfect to imperfect competition does not in itself lead to a horizontal *PS* curve. Additional assumptions are required.

[9] For the (absolute value of the) elasticity of demand above 5, the approximation is close. For other values of the elasticity, it is necessary to use the exact definition of the mark-up.

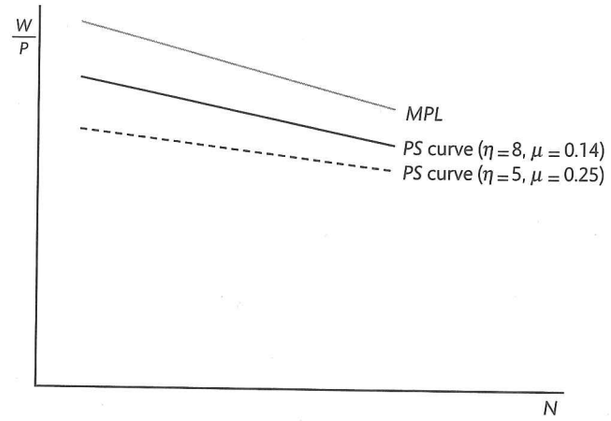

Figure 2.11 Relationship between the *MPL*, the price elasticity of demand (η), and the *PS* curve.

Two alternatives are:

1. If the marginal product of labour is constant (which implies that it is equal to the average product) and the mark-up is constant, the price-setting real wage is equal to a constant fraction of labour productivity.
2. If firms set their prices using a rule of thumb, basing their price on their average costs over the business cycle (i.e. as the economy moves from recession to boom and vice versa) the *PS* curve would also flatten. Such a 'normal cost pricing' rule might result from firms wishing to limit the extent to which they modify their prices in response to changes in costs associated with changes in demand.

When looking explicitly at different patterns of how the real wage moves over the course of the business cycle or at the implications of supply-side policies for real wages, we should consider the more general downward-sloping *PS* curve. In other cases, it is more straightforward to use a flat *PS* curve.

Taking the simplest case, to derive a flat *PS* curve, we assume constant productivity and a constant mark-up. Given these assumptions, if firms set prices to deliver a specific profit margin, then the fixed amount of output per worker is split into two parts: profits per worker and real wages per worker. The real wage implied by pricing behaviour is therefore constant and the *PS* curve is flat. Price setting can then be summarized as the marking up of unit labour costs by a fixed percentage, μ,

$$P = (1+\mu)\left(\frac{W}{\lambda}\right), \tag{2.2}$$

where unit labour costs are the cost of labour per unit of output; i.e. $W \times N$ divided by y. We define $\frac{y}{N}$ (output per worker) as λ (lambda, labour productivity) and using the same approximation as above, we have:

$$\frac{W}{P} = \frac{1}{(1+\mu)}\lambda \tag{2.3}$$

$$= (1-\mu)\lambda. \tag{2.4}$$

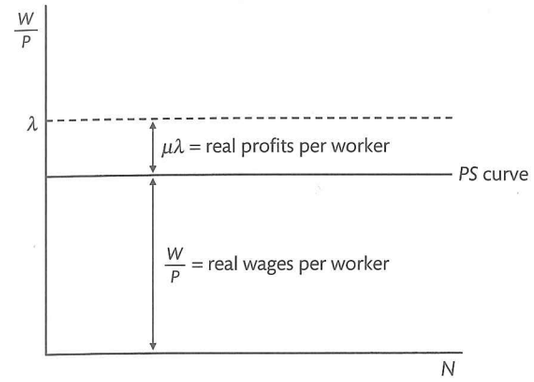

Figure 2.12 The price-setting real wage curve: *PS*.

We write the price setting real wage equation:

$$w^{PS} = \frac{W}{P} = \lambda(1-\mu). \qquad (PS, \text{price-setting real wage equation})$$

In other words, given the mark-up, the level of labour productivity, and the nominal wage, the price level set by firms implies a specific value of the real wage.

A simple rearrangement of the *PS* equation shows how output per worker is decomposed into real profits per worker and the real wage as a result of the firm's price-setting decision and this is illustrated in Fig. 2.12:

$$\lambda = \mu\lambda + \frac{W}{P} \tag{2.5}$$

output per worker = real profits per worker + real wages per worker.

Shifts in the *PS* curve

The tax wedge: how are W and P measured?

Before providing examples of the price-shift variables, one clarification is needed. Once income taxes, labour taxes such as social security contributions and indirect taxes such as VAT are introduced, we have to be clear about what W and P measure and which measure we show on the axis in the labour market diagram. This is a matter of choosing a convention, and we find it convenient to show the real consumption wage in the labour market diagram. This entails measuring W as the post-tax money wage paid to the employee and to measure P_c as the consumer price index, i.e. inclusive of indirect taxes, t_v.

$$P_c = P(1+t_v).$$

This means that when we show $w = W/P_c$ on the axis of the labour market diagram, this is the real consumption wage—the concept relevant from the perspective of the utility of the worker.

By contrast, the real wage that is of relevance to the employer is the real product wage, which is the full cost of labour to firms—inclusive of income tax and non-wage labour costs

such as social security contributions paid by employers and employees—divided by the price the firm gets for its product (i.e. excluding indirect taxes). This is called the producer price. The difference between the real consumption wage and the real product wage is called the *tax wedge*. Given the way we have defined the labour market diagram in terms of W and P_c, the wedge shows up as a price-push factor. Any increase in either direct or indirect taxation reduces the price-setting real wage and therefore shifts the *PS* curve downwards. The derivation of the *PS* curve including the tax wedge is shown in the Appendix.

Price-push factors

We incorporate the tax wedge as one of the price-push factors and write the *PS* curve compactly as:

$$w^{PS} = \lambda F(\mu, \mathbf{z}_p), \qquad \text{(PS curve including price-push factors)}$$

where $\mathbf{z}_p$ is a set of price push variables including the tax wedge.

The *PS* curve shifts up, reducing equilibrium unemployment, when there is

1. a fall in the tax wedge, which is included in $\mathbf{z}_p$,
2. a fall in the mark-up, μ, due, for example, to a change in competitive conditions such as tougher competition policy rules or enforcement, or
3. a rise in productivity, λ.

It is important to note that what matters for shifting the *PS* curve and therefore for affecting equilibrium unemployment is the tax wedge as a whole: a rise in income tax or in indirect tax will push equilibrium unemployment up. There is nothing special about the effect of the so-called payroll taxes, i.e. the employer and employee social security contributions. In Chapter 15, we look at the evidence about how much the equilibrium rate of unemployment is expected to increase if the tax wedge increases by ten percentage points.

Other factors included in $\mathbf{z}_p$ may be regulations that increase the cost of employment, such as business registration and some employment regulations. However, such regulations do not necessarily have the effect of increasing price push and therefore raising the equilibrium rate of unemployment. For example, although regulations enforcing health and safety standards impose costs on firms, they may have a compensating positive effect on productivity.

Equilibrium in the labour market

The labour market is characterized by an upward-sloping *WS* curve and a flat or downward-sloping *PS* curve. The labour market is in equilibrium where the curves cross (see Fig. 2.13):

$$w^{WS} = w^{PS}$$
$$B(N, \mathbf{z}_w) = \lambda F(\mu, \mathbf{z}_p), \qquad \text{(labour market equilibrium)}$$

and this defines the unique equilibrium level of employment N_e. The associated equilibrium rate of unemployment is U_e/L, where L is the labour force.

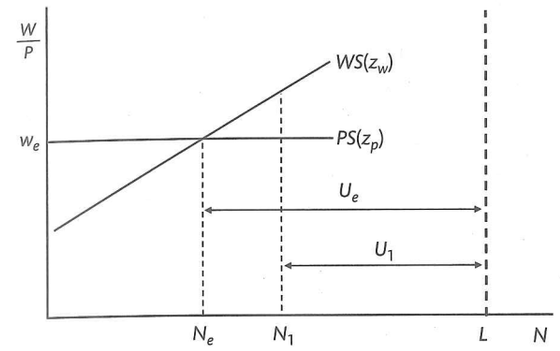

Figure 2.13 Equilibrium employment and unemployment: N_e and U_e.

Unemployment in equilibrium

The equilibrium rate of unemployment is the outcome of the structural or supply-side features of the economy that lie behind the wage-setting and price-setting curves. It can therefore in principle be changed by supply-side policies or structural changes that affect either the wage-push or price-push factors.

An increase in the degree of product market competition—as a result, say, of changes in the application of competition policy or because the internet makes it easier to compare prices—would produce a lower profit margin (μ) and a higher real wage at each level of employment (the *PS* curve would shift up). Similarly, any government policy change that affects wage- and price-setting outcomes will shift equilibrium unemployment. Policies related to the cost of job loss such as unemployment benefits, changes in taxation, labour, and product market regulation and incomes accords are all relevant. It is thus easy to imagine that international differences in policy and in institutional structures produce differences in equilibrium unemployment. We return to analyse supply-side shifts and the evidence regarding their role in explaining cross-country unemployment trends in Chapter 15.

2.2.2 Nominal rigidities, inflation and the business cycle

Demand-driven cycles

In Section 2.1 we explained that the economy will be shifted away from the medium-run equilibrium (where the *WS* and *PS* curves intersect) by fluctuations in aggregate demand. Wages and prices do not adjust spontaneously to keep the economy at equilibrium unemployment. We reported the survey evidence that wages are set periodically and that employers do not cut nominal wages when unemployment goes up.

What about prices? Fluctuations in aggregate demand lead to business cycle upswings and downswings if firms respond to changes in demand by altering output and employment. If prices and wages change but output does not change, then we would not observe demand-driven business cycles. One explanation for demand-driven cycles is that imperfectly competitive firms find it profitable to respond to shifts in demand by changing their

output.[10] Price stickiness refers to the reluctance of firms to change prices in the face of changes in aggregate demand.

The demand curve faced by an imperfectly competitive firm is shifted by shocks to aggregate demand in the economy of the kind introduced in Chapter 1. It is clear from the mark-up equation (price-setting (mark-up) equation) that when profits are maximized, the price will be above marginal cost: the firm will make supernormal profits.

In general, a shift in the firm's demand curve will change the profit maximizing price and quantity. However, since its price exceeds its marginal cost, the firm can afford not to change its price, and its decision comes down to a trade-off between the costs and benefits of doing so. It seems there are costs associated with changing prices. One type of cost is the so-called menu cost. The term comes from the idea that there are costs involved in changing the prices on menus in restaurants. This is a relevant consideration for those firms that operate with posted prices like restaurants, or firms with printed price catalogues. However, these costs seem much less relevant for firms where prices can be changed at the touch of a button. However, even when the technology is available to adjust prices at low cost, a firm may worry that it will lose customers if it changes its price when other firms producing similar products do not. Given that the benefits of changing price are likely to be modest under imperfect competition, the costs do not have to be large to outweigh the benefits.

In the model of pricing we use in defining the price-setting curve, the price is set as a mark up on unit labour costs:

$$P = (1 + \mu)\left(\frac{W}{\lambda}\right). \tag{2.6}$$

This means that the price responds only to changes in labour costs and since productivity, λ, is constant, the price responds only to changes in nominal wages. In this model, firms do not change their prices at all in response to changes in aggregate demand. We can summarize by saying that in the model, prices are sticky in response to shifts in demand and flexible in response to changes in costs, that is, to changes in wages.

A large study has used firm level (i.e. micro) data sources and surveys to investigate price stickiness in the euro area.[11] The authors find that firms in the euro area change their prices infrequently, on average once a year. They also found that the main sources of price stickiness are strategic interactions between competing firms and implicit or explicit contracts with their customers, with menu costs being judged less important. The older survey evidence reported in the overview section noted that firms coordinate their price increases around industry-wide wage rounds.

Business cycles and inflation: the Phillips curve

As we saw in the previous subsection, there is a unique unemployment rate at which the labour market is in equilibrium. At this equilibrium, the *WS* and *PS* curves intersect, which means both wage and price setters are content with the prevailing real wage and have no incentive to alter their behaviour. In this section, we focus on nominal rigidities and how

[10] See Solow (1998) for further discussion of this point.

[11] See Álvarez et al. (2005).

fluctuations in aggregate demand produce business cycle upswings and downswings around the equilibrium rate of unemployment.

To simplify the modelling, we have assumed that labour productivity is constant. This implies that changes in output are reflected by one-for-one in changes in employment. When drawing diagrams, it means that the horizontal shift in output is the same as in employment. In the real world, there is not a one-for-one relationship between changes in output and employment. Okun's law refers to the empirical relationship between a change in aggregate demand, output and the unemployment rate.

Box 2.1 Okun's Law

When output rises, workers who have been kept on the pay-roll but have not been fully employed (e.g. those working shorter than normal hours) may be fully utilized, with the result that higher output does not—at least initially—entail a rise in employment. This is called labour hoarding. Also even if employment rises, unemployment does not necessarily fall if the new jobs are taken by those who were not previously in the labour force. People of working age who are neither employed nor unemployed are called economically inactive and the decision of whether or not to participate in the labour market is dependent on economic conditions.

The combination of labour hoarding and changes in the labour force mean that a 1% change in output growth above or below its trend tends to be associated with respectively a fall or rise in the unemployment rate of less than 0.5 percentage points. This empirical relationship between changes in the growth rate relative to its trend and changes in the unemployment rate is called Okun's Law (an Okun coefficient of −0.5). The responsiveness of unemployment to changes in growth is lower in countries with tighter regulations on hiring and firing (as observed in many continental European countries) and with stronger traditions of lifetime employment (as observed in Japan).

Ball, Leigh and Loungani (2012) find that Okun's Law has been a 'strong and stable relationship' in the major advanced economies since the Second World War. They argue that this relationship did not change substantially in the financial crisis of 2008–09, but that there is a large variation across countries in the coefficient in the relationship (i.e. the degree of responsiveness of the unemployment rate to output). They find an Okun's coefficient of −0.45 for the US, −0.15 for Japan and a much higher coefficient of -0.85 for Spain, where temporary employment contracts are prevalent.

A positive aggregate demand shock increases employment above the equilibrium level, and inflation rises. The timing of events is summarized as before:

Aggregate demand shock → output and employment change

Next wage round → nominal wages change

Immediately after the wage round → prices change

This behaviour is modelled by the Phillips curve. We now need to formalize that relationship to develop the model of inflation and unemployment.

The *WS* curve says that the real wage increases with employment. It simplifies the modelling to express this in terms of the *output gap*, $(y_t - y_e)$, and to write the *WS* curve in linear form:

$$w^{ws}(y_t) = (W/P)^{ws} = B + \alpha(y_t - y_e) + z_w, \qquad \text{(WS curve; linear form)}$$

where B is a constant reflecting the unemployment benefit and the disutility of work, and z_w is the set of wage-push factors. As a result of price setting always restoring the real wage to the equilibrium real wage which is equal to $w_e = B + z_w$, wage setters will attempt to increase the expected real wage by $w^{WS}(y_t) - w_{-1} = w^{WS}(y_t) - w_e = (B + \alpha(y_t - y_e) + z_w) - (B + z_w) = \alpha(y_t - y_e)$. If wage-setters expect prices to increase by $(\Delta P/P)_{t-1}$, we use the approximation $(\Delta W/W)_t - (\Delta P/P)_{t-1} \approx w^{WS}(y_t) - w_{-1}$. Thus we have $(\Delta W/W)_t - (\Delta P/P)_{t-1} = \alpha(y_t - y_e)$ or

$$(\Delta W/W)_t \approx (\Delta P/P)_{t-1} + \alpha(y_t - y_e). \qquad \text{(wage inflation)}$$

This says that wage setters set the percentage increase in the nominal wage to cover the previous period's price increase and to reflect any positive or negative output gap at the time of the wage round.

Turning to price setters, we use the price-setting rule, and noting from the timeline that firms set prices immediately after wages have been set, we have:[12]

$$P = (1 + \mu)\frac{W}{\lambda}, \text{ and}$$

$$(\Delta P/P)_t = (\Delta W/W)_t - (\Delta\lambda/\lambda)_t. \qquad \text{(price inflation)}$$

Substituting the expression for wage inflation into the equation for price inflation gives the following equation for inflation in the simple case where productivity is constant. This is called the Phillips curve:

$$(\Delta P/P)_t = (\Delta P/P)_{t-1} + \alpha(y_t - y_e) \qquad (2.7)$$

$$\underset{\text{current inflation}}{\pi_t} = \underset{\text{lagged inflation}}{\pi_{t-1}} + \underset{\text{output gap}}{\alpha(y_t - y_e)}, \qquad \text{(Phillips curve, } PC\text{)}$$

where π_t is the rate of inflation. If P_t is today's price level and P_{t-1} is last period's price level, then the rate of inflation over the past year is π_t:

$$\pi_t \equiv \frac{P_t - P_{t-1}}{P_{t-1}} = \Delta P/P.$$

[12] The conversion of the price-setting equation into the price inflation equation is carried out as follows. If you are unfamiliar with logs and their properties, see Section 8.3 in Chapter 8. We assume that μ remains constant over time. In continuous time, we find an expression for the growth rate of $P = (1 + \mu)W/\lambda$ by first taking logs, then differentiating with respect to time and using the fact that $\frac{d \log x}{dx} = \frac{1}{x}$:

$$\log P = \log(1 + \mu) + \log W - \log\lambda$$

$$\frac{d \log P}{dt} = \frac{d \log(1+\mu)}{dt} + \frac{d \log W}{dt} - \frac{d \log \lambda}{dt}.$$

By assumption, $d \log(1 + \mu)/dt = 0$.

Multiply each term by $\frac{dx}{dt}$ and use $d \log x/dx = 1/x$

$$\frac{d \log P}{dP}\frac{dP}{dt} = \frac{d \log W}{dW}\frac{dW}{dt} - \frac{d \log \lambda}{d\lambda}\frac{d\lambda}{dt}$$

$$\frac{dP/dt}{P} = \frac{dW/dt}{W} - \frac{d\lambda/dt}{\lambda}$$

$$\pi = \frac{dW/dt}{W} - \frac{d\lambda/dt}{\lambda}.$$

Writing this in discrete time, gives the expression in the text.

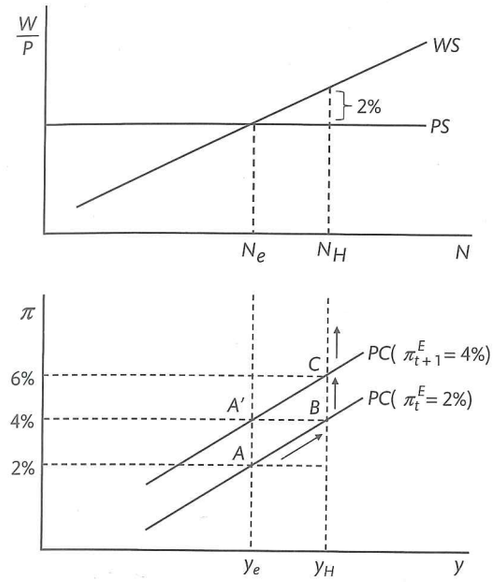

Figure 2.14 The derivation of the Phillips curve.

Graphical derivation of the Phillips curve

In Fig. 2.14, an investment boom because of more optimistic business expectations shifts the *IS* curve to the right. Output and employment rise. The fall in unemployment shifts the balance of power in the labour market towards workers as reflected in the positively sloped *WS* curve. At the next wage round, wage setters respond to the positive output gap: they will need a 2% nominal wage increase to cover last period's inflation plus an additional increase equal to α times the output gap (see the wage inflation equation). In the example shown in Fig. 2.6, this is an extra 2%. Nominal wages go up by 4%.

How do price setters respond to the higher wages? Their labour costs have risen by 4%, so they mark up this cost increase in their prices, and price inflation goes up from 2% to 4% (see the price inflation equation). We have the result that an expansion of aggregate demand that pushes output and employment above the equilibrium level is followed by a rise in wage and price inflation. By joining together points *A* and *B*, we have an upward sloping line in the inflation–output diagram. This is a Phillips curve.

Will inflation stay at 4%? Let us assume that employment remains at its high level until the next wage round. How do wage setters respond? The first thing to notice is that employees will be disappointed with their real wage over the past year: they had expected a high real wage in line with the tighter labour market. This did not eventuate because firms passed on the labour cost increase immediately in higher prices. With this behaviour generalized across the economy, the consumer price index will have risen by 4%. Wage setters will now negotiate a wage increase to make good the erosion of their expected real wage over the past year (an increase of 4%) and they will secure another 2% to take the expected real wage to its high level on the *WS* curve. Firms will follow by putting prices up by 6%. A new Phillips curve

Table 2.1 Constant, rising, and falling inflation.

		Inflation (% per year) and employment			
Period	**Output**	**Lagged inflation**	**'Gap'**	**Wage inflation**	**Price inflation**
−1	y_e	2	0	2	2
		Case 1: constant inflation			
0	y_e	2	0	2	2
1	y_e	2	0	2	2
2	y_e	2	0	2	2
		Case 2: rising inflation			
0	y_H	2	2	4	4
1	y_H	4	2	6	6
2	y_H	6	2	8	8
		Case 3: falling inflation			
0	y_L	2	−2	0	0
1	y_L	0	−2	−2	−2
2	y_L	−2	−2	−4	−4

is defined by joining up point A' and C. Each Phillips curve is labelled by lagged inflation. Case 2 in Table 2.1 shows the output and inflation outcomes following a positive demand shock in period 0.

If we take the converse case of an equal size negative demand shock that moves unemployment above the equilibrium rate and reduces output to $y_L < y_e$, the same reasoning gives the result that inflation is falling. The process will be the exact reverse of that set out above for the positive demand shock. The summary of the output and inflation outcomes for this example is shown as Case 3 in Table 2.1. This example shows that unemployment above the equilibrium is accompanied by falling inflation.

Summary of the Phillips curve (*PC*)

We have shown that the Phillips curve (*PC*) is derived from the wage-setting and price-setting curves. In the formulation of the *PC* that underlies the core 3-equation model, each Phillips curve shows a feasible set of output and inflation pairs for a given rate of lagged inflation. The Phillips curves are pinned down by lagged inflation because of the presence of lagged inflation in the wage inflation equation. Wage setters are interested in the real wage. When setting the nominal wage increase, they take a view about the way the consumer price index is likely to evolve over the course of the wage contract. A simple rule for doing this uses consumer price inflation over the previous period.

In modelling inflation and Phillips curves, it is usual to express the role of lagged inflation in terms of inflation expectations. We use this language and return in Chapter 4 to a detailed investigation of how expectations are formed. Thus, we can write:

$$\pi_t^E = \pi_{t-1}, \qquad \text{(adaptive inflation expectations)}$$

where π_t^E is expected inflation in period t and π_{t-1} is actual inflation in period $t-1$. When we model wage setters' behaviour in wage negotiations in this manner, then we say that

they have *adaptive expectations*. This is because they update their expectations every period based on the out-turn for inflation in the last period. As shown in Fig. 2.14, we pin down the vertical height of the Phillips curve by expected inflation. Throughout this book, we will denote the Phillips curve by $PC(\pi_t^E = x\%)$. In the adaptive expectations case, x is simply last period's inflation rate.

The Phillips curves are upward sloping, reflecting the effect of the output gap, $(y_t - y_e)$, on wages and prices through the wage- and price-setting curves, and hence on inflation. As we saw in the previous subsection, if output is above equilibrium, then inflation will be higher than last period's inflation and vice versa. In the model, workers get a base wage increase equal to lagged inflation, and they also get an additional wage change to reflect the position of the economy relative to equilibrium. A positive output gap will result in a positive additional wage change and a negative output gap the opposite. This reflects the positively sloped wage-setting curve.

We can see from Fig. 2.14 that each adaptive expectations Phillips curve is defined by two characteristics:

(1) the lagged inflation rate (π_{t-1}), which fixes the height of the Phillips curve on a vertical line above the level of output associated with the equilibrium rate of unemployment; and

(2) the slope of the *WS* curve, which fixes its slope.[13] The Phillips curves will be steeper if the *WS* curve is steeper and vice versa.

In equation form, the Phillips curve is:

$$\pi_t = \pi_t^E + \alpha(y_t - y_e)$$

$$\underset{\text{current inflation}}{\pi_t} = \underset{\text{lagged inflation}}{\pi_{t-1}} + \alpha(y_t - y_e)_{\text{output gap}}. \qquad \text{(adaptive expectations Phillips curve)}$$

We can see from this expression that the Phillips curve shifts up or down whenever lagged inflation changes and that its slope depends on α, which in turn reflects the slope of the *WS* curve.

Evidence on inflation dynamics in many countries over the past few decades suggests that changes in output (and employment) are followed by changes in inflation, which is summarized by saying that output leads inflation; and that inflation is persistent.[14] Consistent with this evidence, the Phillips curve states that inflation depends on past inflation, π_{t-1} and the output gap, which reflects the difference between current unemployment and the equilibrium rate of unemployment.

The assumption that prices are adjusted immediately to cost increases means that the real wage remains on the *PS* curve and is constant over the business cycle. Empirically, at the

[13] Note that if the *PS* curve was downward sloping, the slope of the Phillips curve would be steeper, reflecting the slope of both the *WS* and the *PS* curves. At output above equilibrium, for example, there would not only be the 'gap' due to the slope of the *WS* curve but there would be a second 'gap' between the existing real wage and that on the *PS* curve. Firms would push up prices further to reduce the real wage down to the lower real wage on the *PS* curve.

[14] For evidence, see Christiano et al. (2005); also Estrella and Fuhrer (2002) and Muellbauer and Nunziata (2004).

aggregate level, real wages are mildly pro-cyclical. In the model, if lags in price setting are introduced (in addition to the lag in wage-setting due to the annual wage round), then the real wage would lie in between the *WS* and *PS* curves. Real wages would then be pro-cyclical reflecting the upward-sloping wage-setting curve. Real wages would rise in business cycle upswings and fall in downswings.

2.3 Applications

Shocks in the absence of a stabilizing policy maker

We shall see in Chapter 3 that an inflation-targeting central bank will diagnose the nature of a shock and then respond by adjusting the interest rate. To motivate the introduction of a policy maker who seeks to stabilize the economy, we show what happens to the economy when it is disturbed by a demand or supply shock in the absence of such a policy maker. We look in turn at demand shocks, represented in the model by a shift of the *IS* curve or a shift along it due to a change in the interest rate, and at supply shocks, represented by shifts in the *WS* and or the *PS* curves.

An aggregate demand shock

By drawing the *IS* diagram above the labour market diagram we show the positive aggregate demand shock explicitly in Fig. 2.15a (i.e. the left hand panel of Fig. 2.15). Our assumption that there is no stabilizing policy maker is reflected in the fact that the *IS* curve remains at *IS'* following the shock and the real interest rate is kept constant at its initial level, r_e.

We assume the economy begins at equilibrium output y_e with lagged inflation of 2%. A positive aggregate demand shock shifts the *IS* curve to *IS'*. An example of such a shock would be the US economic boom associated with higher government spending (on military and non-military goods and services) that coincided with the start of the Vietnam war in 1965. US GDP growth was 6.4% in 1965 and 6.5% in 1966, compared to an average of just 3.9% for the other years in that decade.[15]

As shown in Fig. 2.15a, the shock is accompanied by ever-increasing inflation: with output above equilibrium at y_H, there is a gap between the *WS* and the *PS* every period, wages and prices are adjusted first as wage setters try to achieve the real wage w_H and second as firms push up prices to restore their profit margin (which implies the real wage is kept at w_e). The process is exactly the same as in the example used to derive the Phillips curve in the last section (see Fig. 2.14 and Case 2 in Table 2.1).

With the real interest rate kept constant at r_e, a positive demand shock is associated with higher employment and rising inflation. In Chapter 3, we address the question of why the policy maker will not be happy with a situation of ever-increasing inflation and what they could do to stabilize the demand shock and get inflation back to the initial level of 2%.

[15] Figures calculated using data on real GDP from the US Bureau of Economic Analysis.

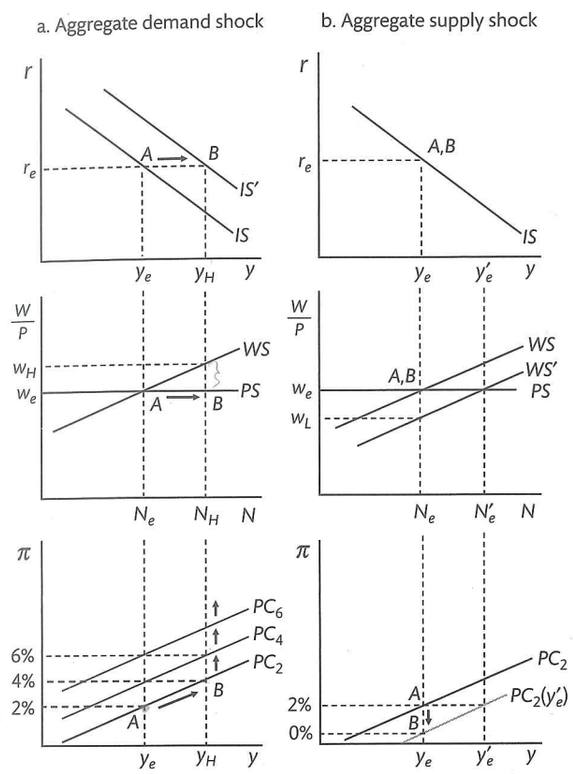

Figure 2.15 World without a stabilizing policy maker: inflationary implications of aggregate demand and supply shocks.

Note: PC_x is used as short form for $PC(\pi_t^E = x\%)$, where x is the level of lagged inflation and t is the time period.

An aggregate supply shock

We now turn to the implications of an aggregate supply shock. We can model an aggregate supply shock as a shift in

1. the production function, i.e. a technology or productivity shock (change in λ)
2. the *WS* curve, e.g. a shift in bargaining power from workers to employers or in any of the other wage-push factors (i.e. $\boldsymbol{z}_w$)
3. the *PS* curve, e.g. more intense competition in the product market (i.e. $\downarrow \mu$) or a shift in any of the price-push factors, (i.e. $\boldsymbol{z}_p$).

To illustrate the implications for output, employment and inflation, we take the example of a downward shift in the *WS* curve. An example of such a shock would be the Dutch supply-side reforms of the 1980s. The Netherlands was seen as one of Europe's 'employment miracles'. In 1983, unemployment stood at 8.3%, whereas the average for the 1990–2008 period was just 4.6%. The Dutch reforms included reduced unemployment benefit generosity, increased

expenditure on active labour market policies to make workers more employable and closer coordination in the wage bargaining process.[16]

To illustrate the key differences in the response of the labour market to supply and demand shocks, we analyse the adjustment of the economy to the supply shock using Fig. 2.15b. We assume the economy begins at equilibrium output y_e with lagged inflation of 2%. A positive supply shock shifts the *WS* curve downward to *WS'*. This raises the equilibrium level of employment from N_e to N'_e and the equilibrium level of output from y_e to y'_e. Again, we assume there is no stabilizing policy maker, so the real interest rate is kept constant at its initial level of r_e following the shock.

At the original output level, y_e, there is now a negative gap between the *WS* and *PS* curves. Wage setters respond to the gap by reducing their real wage claim to w_L. They do this because there is now increased competition for jobs (as a result of the active labour market policies) and a higher cost of job loss (as a result of lower benefit generosity). Wages therefore rise by 0% and in order to keep their profit margins constant firms do not change their prices. Inflation falls from 2% to 0% and the Phillips curve shifts down.

In the following periods, the adjustment of the economy is similar to that of a negative demand shock (see Case 3 in Table 2.1). Inflation falls in each period. This process will carry on indefinitely, as long as output is kept below the new equilibrium—i.e. unemployment cannot be kept at a level above equilibrium without falling inflation.

A positive supply shock is defined as one that raises equilibrium output and employment. We have shown that a positive supply shock is associated with falling inflation *at the initial output level* $y = y_e$. If the supply shock is permanent, then the economy is capable of operating with lower unemployment and constant inflation. As we shall see in Chapter 3, the policy maker is likely to respond to the shock by reducing the interest rate to allow the economy to operate at the new equilibrium output level of y'_e with constant inflation.

2.4 Conclusions

This chapter has provided the second building block for the model of the macro-economy. We have set out the *WS* – *PS* model, which is used to determine the equilibrium level of output in the economy. From the *WS* – *PS* model, we derived the Phillips curve, or *PC*, which is used to model wage and price inflation and is one of three equations that underpins the 3-equation model of the macro-economy that will be set out in the next chapter.

The *WS* – *PS* model shows that wages at equilibrium unemployment are higher than workers would be willing to accept; this means there is involuntary unemployment. With monopolistic (or equivalently imperfect) competition in goods markets, firms charge a mark-up on their goods and make supernormal profits. At the supply-side equilibrium, the rate of unemployment is such that both wage and price setters are content with the prevailing real wage. The real wage is constant, which implies that wages and prices are rising at the same rate: inflation is constant. Inflation could be constant at a rate of zero, in which case nominal

[16] See Nickell and Van Ours (2000a).

wages and prices would remain unchanged. Modern economies are typically characterized by positive inflation.

By combining the analysis of aggregate demand summarized in the *IS* curve with the supply side (*WS* and *PS* curves), we can analyse current and historical episodes of unemployment. For example, we can model both the rapid growth of unemployment following the global financial crisis and the gradual increases in equilibrium unemployment that characterized many European economies from the 1970s. In the first case, there was a large negative aggregate demand shock, which pushed economies away from their constant inflation equilibrium unemployment rates and increased involuntary unemployment. In the second case, negative supply shocks pushed up equilibrium unemployment, leaving it higher, even when stable inflation was restored.

Given the economy's supply side characteristics, the Phillips curve shows the feasible set of inflation and output pairs for a given rate of lagged inflation. We can interpret the lagged inflation term either as agents forming expectations about how prices will evolve in a backward-looking manner or as agents negotiating wage increases to compensate them for the erosion of their real wages associated with last period's inflation. We shall show in the next chapter that the Phillips curve acts as a constraint on the policy maker, limiting their choice of viable inflation–output combinations in each period.

The modelling undertaken in Sections 2.2 and 2.3 has provided a framework with which we can shed light on important questions concerning the supply side of the economy. As a summary of the chapter, we return to each of the key questions posed in these sections:

1. **Supply side effects on equilibrium unemployment.** What determines the medium-run equilibrium level of output and unemployment around which the economy fluctuates? The equilibrium rate of unemployment is pinned down by the intersection of the *WS* and *PS* curves. Structural features of the economy, such as unionization, along with policy choices, such as the generosity of unemployment benefits and the stringency of competition policy, will affect equilibrium unemployment. Swings in demand will move the economy away from equilibrium, resulting in actual unemployment deviating from equilibrium (see Fig. 2.8). Unemployment below equilibrium is associated with output above equilibrium, i.e. a positive output gap ($y > y_e$). In Chapter 15, we shall consider possible feedback from actual to equilibrium unemployment, which is referred to as 'hysteresis'.

2. **Nominal rigidities, inflation and the business cycle.** What happens to inflation when the economy is away from equilibrium? When output is above equilibrium, the increased tightness of the labour market is reflected in a higher wage-setting wage. There is a lower cost of job loss and workers will need to expect higher real wages in order to exert effort. These are expected real wages because the real wage outturn depends on what happens to inflation in the economy as a whole over the period of the wage contract. In this case *WS* > *PS*, and workers will get a wage increase that more than compensates them for the erosion in real wage due to last period's inflation. However, firms protect their profit margins and will immediately raise prices following the wage round. This means that workers' real wage expectations are constantly frustrated when output is above equilibrium. The only way in which output can remain above equilibrium is with rising inflation, as shown in Fig. 2.14. The opposite is true for output below equilibrium. The relationship between output and inflation can be summed up by the Phillips curve: $\pi_t = \pi_{t-1} + \alpha(y_t - y_e)$. This equation shows that

the current period's inflation (π_t) depends positively on both last period's inflation (π_{t-1}) and the output gap ($y_t - y_e$).

3. **Demand shocks, supply shocks and the Phillips curve.** How does the economy respond to demand or supply shocks in a world without a policy maker who aims to stabilize the economy? The economy reacts differently to supply and demand shocks. We can highlight these differences by seeing how they are captured by different parts of the model. Demand shocks affect the *IS* curve and supply shocks affect the *WS* or *PS* curves and consequently the Phillips curve, *PC*. A positive demand shock leads to ever-increasing inflation as long as demand is kept at a level where there is a positive output gap. In contrast, a positive supply shock increases equilibrium output and is associated with falling inflation as long as output is kept at the initial equilibrium rate of output. Falling inflation signals that the economy is capable of operating at a higher equilibrium level of output.

Having a framework of the kind set out in Chapters 1 and 2 is essential in understanding how policy makers assess the state of the economy and whether intervention is required. This sets the stage for the introduction of the policy maker with stabilization objectives in the next chapter. In Chapter 3, we show why governments introduced inflation-targeting central banks in a bid to improve economic performance.

2.5 Appendix

2.5.1 The textbook model: competitive markets and complete contracts

To help bring out the way the labour market works and to clarify the notion of involuntary unemployment, it is useful to provide a comparison with a simple textbook model. In the textbook model, the intrinsic feature of the labour market of variable effort is neglected. It is assumed that the wage buys a specific amount of work.

What would a market for labour mean when employment contracts are complete? The image to have in mind is not of the labour market in a real economy but of a hiring hall where employers and workers gather. In the hall, employers shout out job offers and workers respond. Since the textbook model assumes that what the employer gets in exchange for a particular hourly wage offered is unambiguous, he will be happy to hire labour on this basis. In the hiring hall, a wage is posted and workers respond by accepting or declining to work.

As discussed in Section 2.1, we assume the labour supply curve to be quite inelastic. This reflects the offsetting income and substitution effects of a wage change, as well as the effects of changes in labour force participation. Imagine the wage offers are being broadcast outside the hiring hall and people are drawn in to participate in the labour market by higher wage offers.

Turning to the labour demand side, in the textbook model, there is a downward-sloping labour demand curve, which shows the labour demanded at a given real wage. Assuming for simplicity that the capital stock (K) is fixed, output is a positive function of the level of employment (N), i.e.

$$y = f(N; K),$$

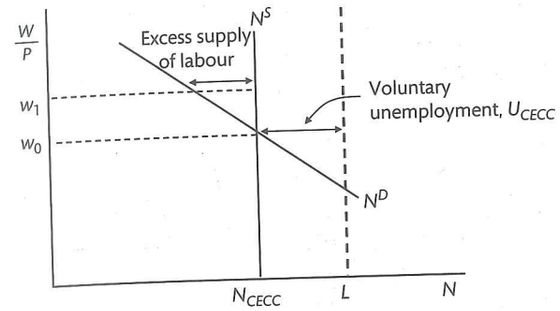

Figure 2.16 Market clearing equilibrium in a textbook labour market with complete employment contracts.

where f is the production function. It is assumed that the production function is characterized by diminishing returns, which means that as more workers are employed–holding capital constant–the extra output produced by each additional worker declines. Another way of putting this is that the marginal product of labour, which can be written as $\frac{\partial y}{\partial N}$ or *MPL*, declines as employment rises. The labour demand curve (N^D) is often referred to as the *MPL* curve since under perfect competition, firms take the real wage as given and employ labour up to the point at which the marginal product of labour is equal to the exogenously given real wage (the wage shouted out in the hiring hall).

The market clears at the real wage where the labour demand curve intersects the labour supply curve. Bringing together the labour demand and labour supply schedules as in Fig. 2.16, the labour market clears with the real wage w_0 and employment, N_{CECC} (for Competitive Equilibrium Complete Contracts).

Any temporary displacement of the economy from equilibrium is assumed to be eliminated by a movement in real wages. For example, if the real wage rises above the market-clearing level (due say, to an unexpected fall in the price level), then labour supply exceeds labour demand at that real wage (w_1). The excess supply of labour will result in falling nominal wages until the unique competitive equilibrium is re-established with the real wage at w_0 and employment at N_{CECC}. In this model, the only people who will be unemployed will be those *voluntarily* unemployed in the sense that at the going real wage, they prefer searching for a job or leisure over the goods and services obtainable through working.

In Fig. 2.16, the rate of unemployment in the market-clearing equilibrium is U_{CECC}/L, where L is the labour force, i.e. the sum of the employed and the unemployed. It is important to remember that in the textbook model, the economy is at a welfare optimum in the market-clearing equilibrium, so the voluntary unemployment that exists does not signify a problem. Rather, it reflects the choice by workers about whether and how much to work at the existing real wage. It is difficult to motivate the study of supply-side institutions and policies and of demand-side (that is, stabilization) policy in this model.

2.5.2 The mark-up and the elasticity of demand

A firm maximises profits when marginal revenue (*MR*) = marginal cost (*MC*). With labour as the single factor of production this means that

$$MC = \frac{W}{MPL}, \qquad \text{(marginal cost)}$$

where W is the nominal wage and MPL the marginal product of labour.

Total revenue is

$$R = Py, \qquad \text{(total revenue)}$$

where P is the price for which the firm sells their output, and y is the quantity of output they sell. The firm faces a standard downward-sloping demand curve. The elasticity of this demand curve, η, measures the responsiveness of output demanded to a change in the price. If there is perfect competition, the demand curve is flat and $\eta = \infty$, since under perfect competition, a marginal increase in the price will mean the firm loses all of its sales. The less elastic demand (in absolute value) is the demand curve, the less demand the firm loses by increasing its price.

Marginal revenue is

$$MR = \frac{dR}{dy} = P + y\frac{dP}{dy}. \qquad \text{(marginal revenue)}$$

If we divide each side of the equation for marginal revenue by P and substitute in the definition of η, where

$$\eta = -\frac{dy}{dP}\frac{P}{y}, \qquad \text{(elasticity of demand)}$$

we get

$$MR = P + y\frac{dP}{dy}$$

$$\frac{MR}{P} = 1 - \frac{1}{\eta}$$

$$\rightarrow MR = P\left(1 - \frac{1}{\eta}\right).$$

Then at the profit-maximizing optimum, where $MR = MC$, we have

$$P\left(1 - \frac{1}{\eta}\right) = \frac{W}{MPL}$$

or

$$P = \left(\frac{\eta}{\eta - 1}\right)\frac{W}{MPL}. \qquad \text{(pricing formula, in terms of elasticity, } \eta)$$

This can be written in terms of a mark-up μ on marginal labour costs

$$P = (1 + \mu)\frac{W}{MPL}, \qquad \text{(pricing formula, in terms of the markup, } \mu)$$

where $\mu = \frac{1}{\eta - 1}$.

In the case of perfect competition $\eta = \infty$ and $\mu = 0$. As the demand curve becomes more inelastic, the mark-up, μ, rises. If, for example, $\eta = 6$, the firm will mark up marginal costs by 20%; $\mu = \frac{1}{\eta - 1} = \frac{1}{6-1} = 0.2$.

2.5.3 Deriving the *PS* curve including the tax wedge

The wage element of costs for firms is the full cost of labour to firms—i.e. the gross wage paid to the worker (which includes the income tax and social security payments that have to be made by the worker) plus the employer's social security contributions. All direct taxes are summarized in the tax rate, t_d. This is shown in the pricing equation, where P is the producer price:

$$P = (1 + \mu)\frac{W^{\text{gross}}}{\lambda} = (1 + \mu)\frac{W(1 + t_d)}{\lambda}. \qquad \text{(price equation)}$$

But to get the *PS* curve we need the price-setting equation in term of the consumption price, $P_c = (1 + t_v)P$, so that:

$$P_c = (1 + t_v)P = (1 + t_v)(1 + \mu)\frac{W(1 + t_d)}{\lambda},$$

which implies

$$\frac{W}{P_c} = \frac{1}{(1 + \mu)}\frac{\lambda}{(1 + t_d)(1 + t_v)}$$

and using our approximation that $\frac{1}{1+\mu} \approx 1 - \mu$, we have:

$$w^{PS} = \frac{W}{P_c} = \frac{\lambda(1 - \mu)}{(1 + t_d)(1 + t_v)}. \qquad \text{(}PS\text{ equation including tax wedge)}$$

An approximation to the tax wedge is given by: $\frac{1}{(1+t_d)(1+t_v)} \approx (1 - t_d - t_v)$. We can see that:

1. Any fall in the wedge, for example, a fall in income tax, implies an upward shift in the *PS* curve, indicating that the real wage is higher at any level of employment since the tax take is smaller.
2. The smaller wedge means that *WS* and *PS* curves cross at higher employment: there is a lower equilibrium rate of unemployment because a higher real consumption wage on the *WS* curve is consistent with equilibrium for price setters (on the new higher *PS* curve).

2.6 Questions

2.6.1 Checklist questions

1. Explain in words and using a diagram what is meant by labour market clearing (refer to Appendix 2.5.1). Why is labour market clearing not observed in real-world labour markets?
2. Why is the wage-setting curve upward sloping? If there is a disutility of working, why are workers unhappy when they are unemployed?
3. Derive the price-setting curve. What does the equation for the *PS* curve tell us about the ability of firms to make supernormal profits? Explain in words why the decisions of firms about what price to set has implications for the real wage in the economy. Provide two different explanations for why the *PS* curve might be flat.
4. What is being assumed about the timing of wage setting and price setting that enables us to say that the economy is always on the *PS* curve but only on the *WS* curve in a medium-run

equilibrium? What timing assumptions would deliver the result that the economy is always on the *WS* curve but only on the *PS* curve in a medium-run equilibrium?

5. Explain in words the inflationary consequences of an upswing in aggregate demand. Assume the economy is initially at equilibrium and make sure you adequately explain the transmission mechanisms as well as the final result.
6. Evaluate the following statement:
   'When the economy is in equilibrium in the *WS* – *PS* model, there is only voluntary unemployment, because no agent has an incentive to change their behaviour.'
7. Equation 2.2 in Section 2.2.1 shows that firms set prices as a mark up over unit labour costs. Use this equation to show the relationship between wage growth and price growth in the economy. What assumptions do we have to make for wage changes to translate one-for-one into price changes? In this case, how will a rise in wages impact on a firm's profit margin?
8. Assess the following statements S1 and S2. Are they both true, both false or is only one true? Justify your answer.
   S1. When output is above equilibrium, wage setters will secure wage increases that reflect the tightness of the labour market.
   S2. If output is consistently above equilibrium, then wage-setters' real wage expectations are constantly frustrated.
9. Use the *WS* – *PS* model to graphically derive a set of Phillips curves. Explain the intuition behind the diagram. Provide an explanation of how a situation of deflation could occur (deflation is a situation in which inflation is negative so that prices are falling). What are you assuming about the real interest rate?
10. Giving in each case an example of what could have caused it, explain how unemployment can be above equilibrium due to the following. Use diagrams, such as those in Fig. 2.15, to show the inflationary implications of each shock (assume there is no stabilizing policy maker).
    (a) Aggregate demand being too low
    (b) A wage-setting shock

2.6.2 Problems and questions for discussion

1. Collect an inflation report from the central bank website of an OECD economy (e.g. the Bank of England, the ECB, the Federal Reserve etc.) and answer the following questions:
   (a) What factors do they view as important drivers of inflation (or the outlook for inflation)?
   (b) Divide these factors into supply-side and demand-side factors.
   (c) For each factor, provide a plausible explanation for which curve of the model they affect (e.g. *IS*, *WS* or *PS*).
   (d) For each factor, in which direction would you expect the affected curve to shift?
2. Read the following statement and then answer the questions below: 'Just by looking at real-world labour markets, it is obvious they are far too complex to be accurately modelled by either the efficiency wage model or the textbook model with complete contracts'. [Hint: the textbook model is set out in the Appendix.]
   (a) Does the statement provide a good justification for not using a model when thinking about the supply side of the economy?

   (b) What are the key predictions of the efficiency wage model and the textbook model with complete contracts?
   (c) The predictions of which model more closely match what we observe by analysing real-world data? Provide examples to justify your answer.
3. Consider two key events in recent economic history; the credit crunch that plunged the world into recession in 2008 and the Fukushima nuclear disaster that struck Japan in 2011. Find data on the path of the monthly harmonized unemployment rate from the start of 2007 onwards for both the US and Japan using OECD.Stat. Answer the following questions:
   (a) Describe (i) how US unemployment reacted to the credit crunch; and (ii) how Japanese unemployment reacted to the Fukushima nuclear disaster.
   (b) Using the material in this chapter and the previous chapter, make an assessment of which curves were likely to have been affected by these economic shocks—i.e. was it the *IS*, *WS* or *PS* curve that were affected (or some combination of them)? Make sure you justify your answer.
   (c) Given your answer to part (b), do you predict that the equilibrium level of unemployment shifted in response to these shocks? Justify your answers.
4. Collect data for GDP and the unemployment rate for OECD economies between 2007 and 2010 from OECD.Stat. Produce a scatterplot of percentage point changes in GDP and the unemployment rate (from peak to trough) over the course of the Great Recession. Answer the following questions:
   (a) Describe briefly what the graph shows.
   (b) Does the data support Okun's Law (i.e. an Okun coefficient of -0.5)?
   (c) If not, then suggest some factors that might account for the differences in Okun coefficients observed across the OECD economies.