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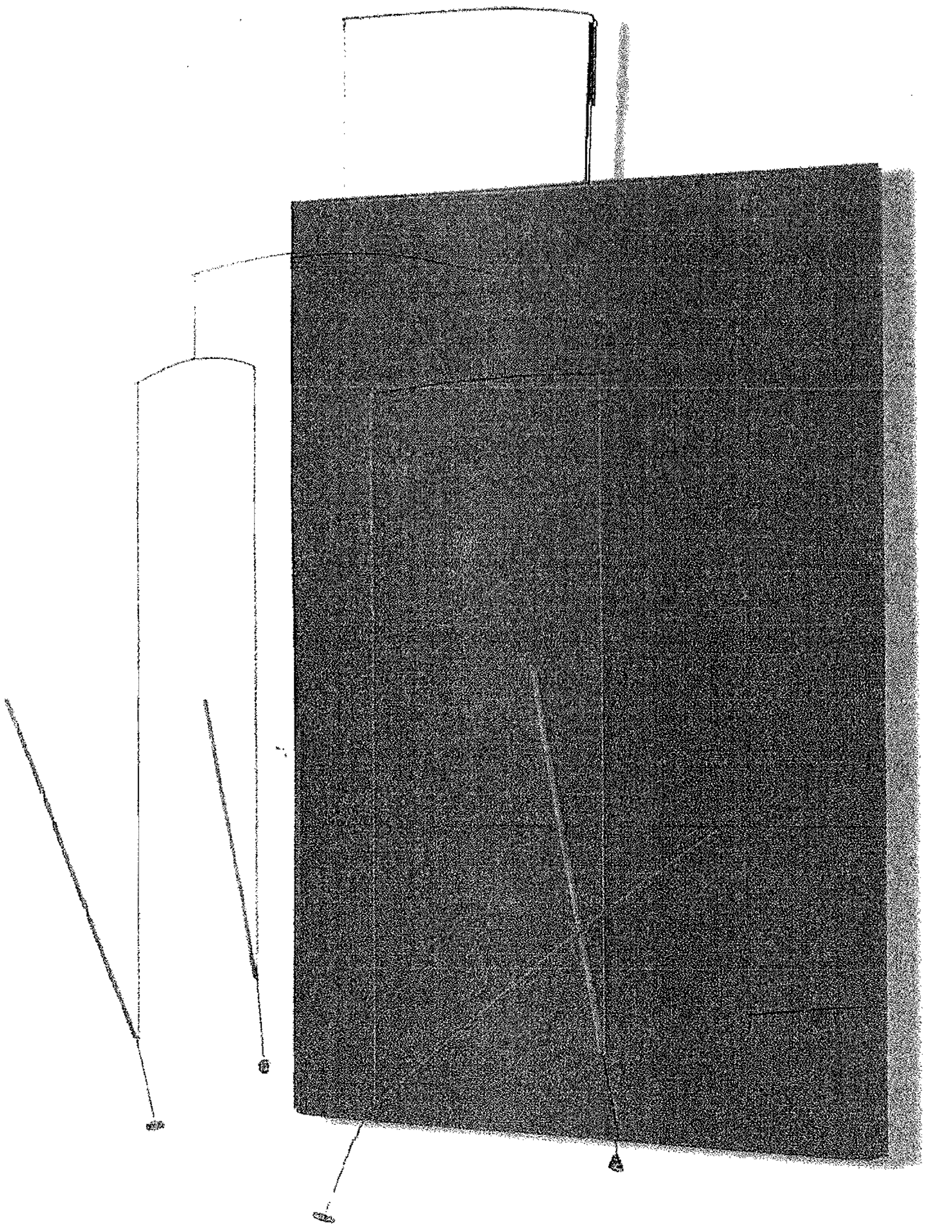
MACROECONOMICS

Imperfections, Institutions & Policies



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INDIAN EDITION

2 Aggregate Demand, Aggregate Supply, and Business Cycles

This chapter begins the process of setting out the short- to medium-run macro model. The first aim of the chapter is to explain how the level of output and employment is determined by the level of aggregate demand in the short run—i.e. when wages and prices are sticky. This provides a model of the business cycle, i.e. how the level of output and employment fluctuates in response to changes in aggregate demand. We begin with the standard approach of introducing the goods market equilibrium and then the money market equilibrium in the *IS/LM* model. The *IS* refers to the goods market and the *LM* to the money market. There are two broad ways of thinking about how monetary policy is implemented by governments or central banks and hence about the usefulness of the *LM* analysis. On the one hand, the government or central bank can be modelled as implementing monetary policy through its control over the level or the growth rate of the money supply. We shall see that this approach is best handled using the *LM*. On the other hand, the government or central bank can be seen as setting the interest rate so as to stabilize the economy and steer it toward an inflation target. This is the so-called monetary rule (*MR*) approach developed in Chapter 3.

Given the increasing prevalence of monetary rules in monetary policy-making, the question arises as to why should we bother with presenting the *LM* analysis at all?

- First, if we are to understand why governments and central banks have moved toward the use of monetary rules, it is useful to have a sound understanding of the *LM* approach as a benchmark. Moreover, even if the central bank is using the *MR* approach, the *LM* still exists since it represents equilibrium in the money market.

- Second, the *LM* approach is helpful in analysing problems of deflation—i.e. when prices are falling in the economy. Even if the central bank uses a monetary rule to adjust the interest rate to achieve an inflation target, we need to understand the circumstances under which this may be ineffective. An important example is the situation where the nominal interest rate is close to zero and the economy is characterized by a falling price level, as has characterized the Japanese economy for nearly a decade.

- Third, as we shall see in Chapter 9, much open economy analysis is conducted using the *IS/LM* model.

All three reasons suggest that even if the *LM* is less relevant for practical policy analysis than was once thought, it remains a useful modelling tool. The *IS/LM* model can be used for analysing the determinants of output in the short run when the government controls the money supply. It also provides components that are useful later on. We shall see that the *IS* curve is a key part of the 3-equation *IS-PC-MR* macro model developed in Chapter 3 for use with a monetary rule.

In the second part of this chapter, the focus shifts from aggregate demand to aggregate supply. As we shall see, in the medium run, wages and prices respond to changes in the level of activity (i.e. to changes in output and employment). The second task of the chapter is therefore to pin down the determinants of the medium-run level of employment at which the labour market is in equilibrium and pressures for wages and prices to change are absent. The integration of the short- and medium-run components is introduced in the final section of the chapter through the use of the aggregate demand and aggregate supply framework.

We contrast the explanation of business cycle fluctuations based on shifts in aggregate demand in the presence of sticky wages and prices on which we concentrate in this book with a completely different one, where it is shifts on the supply side of the economy such as technological change that produce booms and recessions. This second approach is called the Real Business Cycle model.

1 Aggregate demand

To understand how the level of output is determined in the short run, we look for the sources of changes in the aggregate demand for output. The short run is defined here as the period during which prices and wages are given. There are a number of ways of explaining why prices and wages might not respond *immediately* to changes in demand. Institutional arrangements normally mean that wages are reviewed periodically and not continuously. A common argument in support of price stickiness is that there are costs associated with changing prices, which are referred to as menu-costs. It is also useful to remember that it is profitable for firms in imperfectly competitive markets to increase output in response to higher demand even if the price remains unchanged. For the moment, we just assume that wages and prices are sticky—they do not respond to changes in employment or output in the short run. A more detailed discussion of the implications of price and wage behaviour for macroeconomics is presented in Chapter 15. The following terms are used by different authors to refer to this assumption: 'nominal rigidity', 'sticky wages, prices', 'fix-price'.

The standard model that is used to summarize the way in which the level of output is determined by aggregate demand in the short run (i.e. with sticky wages and prices) is the *IS/LM* model.[1] It consists of two parts: the goods market and the money market. We think of a short-run equilibrium in the economy as a situation in which both the goods and the money market are in equilibrium. The goods market part is labelled *IS* after the '*I*nvestment-*S*avings' version of the goods market equilibrium condition: planned investment must be equal to planned savings for equilibrium in the goods market. The money

[1] The model was introduced by John Hicks in 1937 (Hicks 1937). For a concise and interesting discussion of its origins and impact, see Leijonhufvud (1987).

market part is labelled *LM* after the equality between money demand (*L*iquidity) and *M*oney supply when the money market is in equilibrium. In *IS/LM* equilibrium, the level of output (and employment) and the interest rate are constant.

The model is useful because it allows us to work out what happens to output and to the interest rate when there is a change in aggregate demand or when the government changes its policies. On the *IS* side, we can analyse:

- shifts in consumption or investment
- changes in fiscal policy, i.e. in government expenditure or taxation.

On the *LM* side, we can analyse:

- shifts in money demand
- changes in monetary policy, e.g. in the money supply.

2 The goods market: the *IS* curve

The *IS* curve shows the combinations of the interest rate and output level at which there is equilibrium in the goods market. For goods market equilibrium, the aggregate demand for goods (and services) must equal the supply. Since we assume that wages and prices are fixed, the supply of output will adjust to any change in aggregate demand.

Aggregate demand refers to the planned real expenditure on goods and services in the economy as a whole. Equilibrium requires that planned real expenditure on goods and services is equal to real output:

$$y^D = y, \qquad \text{(goods market equilibrium)}$$

where y^D is planned real expenditure and y is real output.

Aggregate demand is made up of planned expenditure on consumption and investment by the private sector and planned government spending. It can be written as

$$y^D = c(y, t, \text{wealth}) + I(r, A) + g \qquad \text{(aggregate demand)}$$

where c is consumption, I is investment, and g is government spending, all in real terms. t is total taxation, r is the real rate of interest, and A refers to other (non-interest rate) determinants of investment. In general, we use lower case letters to refer to real variables and upper case ones to refer to nominal variables so y is real output and Y is output in money terms (e.g. in euros or dollars). However, this is not always possible: we use i for the nominal interest rate and I for real investment.

Some important features of the short-run macroeconomic model can be shown most easily if we assume linear functions. We shall use a simple linear consumption function that says consumption is a function of current post-tax (i.e. disposable) income and other factors such as wealth that are summarized in a term labelled autonomous consumption, which is assumed to be constant:

$$c = c_0 + c_y(y - t) \qquad \text{(consumption function)}$$

where c_0 is autonomous consumption and c_y is the constant proportion of current disposable income that is consumed: $0 < c_y < 1$. The term c_y is called the marginal propensity to consume out of disposable income. Disposable income is income minus taxation $(y - t)$. t is the total tax revenue, and if we take a linear tax function, then

$$t = t_y y \qquad \text{(tax function)}$$

where $0 < t_y < 1$. Thus if we substitute the tax function into the consumption function and rearrange the terms, the consumption function is:

$$c = c_0 + c_y(1 - t_y)y.$$

A notable feature of this consumption function is that consumption is affected by the current level of activity in the economy. In Chapter 7, we look at the microfoundations of consumption behaviour to see why current *and expected future* income are likely to be relevant for consumption expenditure. The simplest way to incorporate the insights of the forward-looking model of consumption is by including in c_0 the determinants of expected future income. The consumption function shifts when expected future income changes. The empirical evidence discussed in Chapter 7 confirms that current and expected future income influence current consumption.

Investment is assumed to depend negatively on the real rate of interest and positively on expected future profitability, the determinants of which are proxied by the term A. The simple idea is that firms are faced with an array of investment projects, which are ranked by their expected return. If the interest rate falls, then this reduces the cost of capital and makes some projects profitable that would not otherwise have been undertaken. Similarly, if the expected return on projects rises (because there is a surge of optimism in the economy), then at any given interest rate, more projects will be undertaken. We can write this investment function:

$$I = I(r, A). \qquad \text{(investment)}$$

It is sometimes handy to use a linear form, $I = A - ar$, where a is a constant. Expectational or confidence factors are often considered crucial determinants of investment behaviour. This would imply that shifts of the investment function arising from changes in A could be of greater significance than movements *along* the investment function in response to interest rate changes. A deeper examination of investment behaviour based on microeconomic foundations is to be found in Chapter 7.

The *IS* curve is defined by the goods market equilibrium condition $(y^D = y)$. To derive an explicit form for the *IS* curve, we use the linear versions of the consumption and investment functions and substitute them into the planned expenditure equation:

$$y^D = c_0 + c_y(1 - t_y)y + A - ar + g. \qquad \text{(planned expenditure)}$$

The planned expenditure equation is then substituted into the goods market equilibrium condition. We rearrange, using the fact that in the goods market equilibrium, $y^D = y$, and replacing $(1 - c_y)$ by the marginal propensity to save, s_y, to define an equilibrium locus of combinations of the interest rate and output:

$$\begin{aligned} y &= \frac{c_0 + A + g}{1 - c_y(1 - t_y)} - \frac{a}{1 - c_y(1 - t_y)} \cdot r \\ &= \frac{1}{1 - c_y(1 - t_y)} \cdot [c_0 + (A - ar) + g] \\ &= \underbrace{\frac{1}{s_y + c_y t_y}}_{\text{multiplier}} \cdot [c_0 + (A - ar) + g]. \end{aligned}$$

The *IS* curve states that for a given interest rate the level of investment is fixed; to this level of investment is added autonomous consumption and government spending; and the associated level of output is found by multiplying the sum by the constant, $\frac{1}{s_y + c_y t_y}$, which is known as the multiplier. Savings and taxation both represent leakages from the feedback from income to expenditure. The reason that the tax leakage (t_y) is multiplied by c_y is that only that part of tax revenue that would have been spent constitutes an extra leakage over and above savings. The *IS* curve is downward sloping because a low interest rate generates high investment, which will be associated with high output. By contrast, when the interest rate is high, investment and hence equilibrium output is low.

The *IS* curve is derived graphically in Fig. 2.1. At r_H, investment ($I_0 = A - ar_H$), autonomous consumption and government spending are shown. Multiplying $I_0 + c_0 + g_0$ by the multiplier gives output equal to planned expenditure, y_0, on the *IS* curve. Using the same logic, at a low interest rate, planned expenditure will be high owing to high investment. Goods market equilibrium dictates a correspondingly high output level.

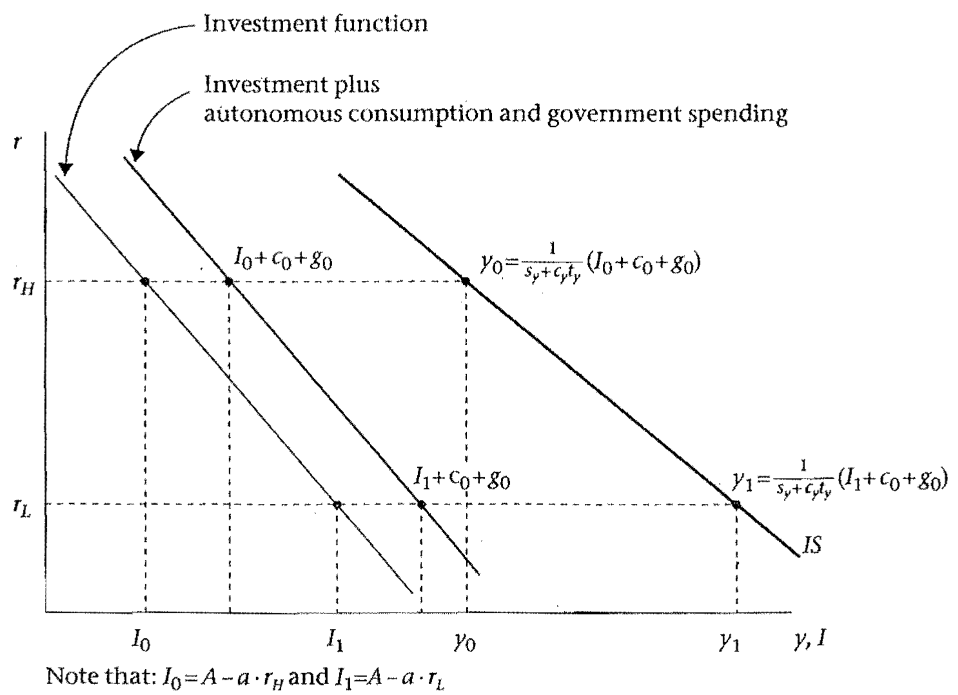

Figure 2.1 Deriving the *IS* curve

Using the *IS* curve equation and the diagram, we can separate the determinants of the slope and position of the *IS* curve into three groups.

(1) Any change in the size of the *multiplier* will change the slope of the *IS* curve. For example, a rise in the propensity to consume will increase the multiplier, making the *IS* flatter: it rotates counter-clockwise from the intercept on the vertical axis.

(2) Any change in the *interest sensitivity of investment* (a) will lead to a consequential change in the slope of the *IS* curve: a less interest-elastic investment function will be reflected in a steeper *IS* curve.

(3) Any change in *autonomous consumption* or in *government expenditure* (c_o, g) will cause the *IS* curve to shift by the change in autonomous spending times the multiplier. A change in the variable A in the investment function also shifts *IS*.[2]

Policy can be used to manipulate the *IS* curve through channels 1 and 3. For example, if income tax is proportional, i.e. if $t = t_y y$, a lower tax rate increases the size of the multiplier and, as in 1 above, swings the *IS* to the right, making it flatter. Any change in government spending will shift the *IS* in the manner described in (3) above.

A feature of the *IS* model of the goods market is that quantities adjust through the multiplier process to take the economy to a stable short-run equilibrium. For example, a fall in planned investment leads to a multiple contraction of output and employment until the level of income has fallen to the extent required to make saving equal to the lower level of investment. Initially, income falls by the fall in investment, ΔI. As the result of the fall in income and assuming $t_y = 0$, consumption declines by $\Delta c = c_y \Delta I$. This fall in consumption in turn reduces income, and in the next round consumption falls once more: $\Delta c = c_y(c_y \Delta I) = c_y^2 \Delta I$. To calculate the total drop in income, we sum the series:[3]

$$\begin{aligned}
\Delta y &= \Delta I + c_y \Delta I + c_y^2 \Delta I + c_y^3 \Delta I + \cdots \\
&= (1 + c_y + c_y^2 + c_y^3 + \cdots)\Delta I \\
&= \frac{1}{1 - c_y} \cdot \Delta I \\
&= \frac{1}{s_y} \cdot \Delta I = \text{multiplier } \times \Delta I
\end{aligned}$$

The change in output is equal to the multiplier (i.e. $1/s_y$) times the change in investment.

[2] In the Appendix to this chapter, we show how the statements 1-3 can be made precise in the case of linear functions by working through the algebra and geometry of the *IS* curve.

[3] This is the sum of a geometric series. We want to find an expression for the series $1 + c_y + c_y^2 + c_y^3 + \cdots$, which we call x. If we put

$$x = 1 + c_y + c_y^2 + c_y^3 + \cdots \qquad (2.1)$$

then

$$c_y \cdot x = c_y + c_y^2 + c_y^3 + \cdots \qquad (2.2)$$

and if we subtract 2.2 from 2.1, we have

$$x(1 - c_y) = 1$$

$$\Rightarrow x = \frac{1}{1 - c_y}.$$

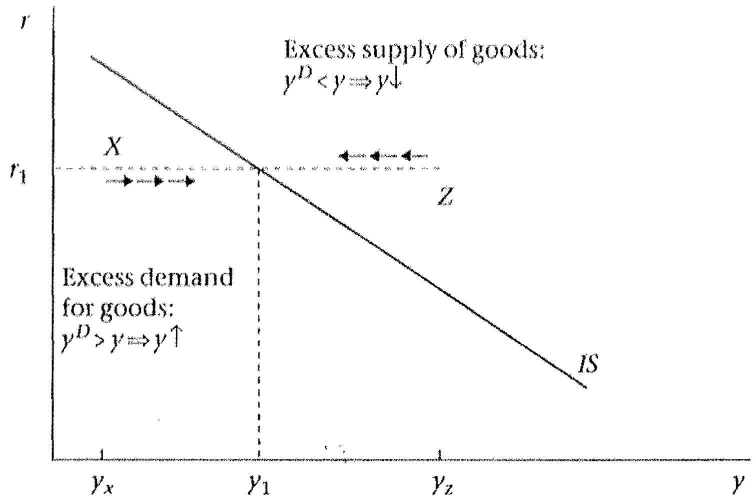

Figure 2.2 Adjustment to goods market equilibrium: excess demand at point X leads to a rise in output; excess supply at point Z leads to a fall in output

Another way of focusing on quantity adjustment to a new goods market equilibrium is to characterize positions off the *IS* curve (Fig. 2.2). At point X with output y_x, to the left of the *IS* curve, there is excess demand in the goods market because at the interest rate r_1, planned expenditure is equal to y_1. With aggregate demand in excess of output, stocks will fall and output will rise until $y = y^D$ on the *IS* curve.

3 The money market: the *LM* curve

The *LM* curve represents the combinations of the interest rate and output at which the money market is in equilibrium, so the focus here is on the way the money market works. Throughout the chapter, it is assumed that the central bank controls the money supply—we model central banks using an interest rate based monetary rule in Chapter 3.

3.1 Demand for money

A common confusion that arises when first studying macroeconomics is between the decision to save and the decision to hold money. The decision to save refers to the use that is made of the flow of income. Of the income received in any given period (e.g. a month) from working and from other sources such as interest income, there is a proportion that is saved and a proportion that is consumed. If consumption exceeds income, then the individual is dissaving—i.e. they are borrowing and accumulating debts.

What then is the 'demand for money'? Whereas the saving decision is an income allocation decision, the demand for money is a decision about the *form* in which to hold your *wealth*. Should you hold it as money or as another asset? To answer this it is necessary to know the difference between money and other assets. When someone asks how much money you have, you might answer by counting the notes or coins in your wallet or you might include the balance in your cheque account because you have instant access to this money by writing a cheque or using a debit card. You might also add in the balances on your other higher interest bank accounts—the 'term' accounts for which you have to give a certain notice period if you want to withdraw money without a penalty. All of these are money and they range from a narrow definition (notes and coins) to a broad one (term deposits). As we move from narrow to broad money, there is a gain in the interest return and a loss in liquidity.

Note that throughout the discussion of money demand and money supply, the relevant interest rate is the *nominal* interest rate, i. One characteristic common to all forms of money is that it is a very or fairly liquid asset and therefore indispensable for carrying out transactions in the economy. Second, if you have €1,000 in your account, then as long as you do not withdraw any of it, the value in money terms does not fall. This means that money is 'capital-safe' in *nominal* terms. If the money is in an interest bearing account, then the nominal amount will rise as interest accrues.

3.1.1 Money and bonds

Although some forms of money do pay interest, there are other assets available in the economy that offer a higher return than a term deposit as long as you are prepared to take on some risk. In addition to supplying money, the government can borrow from the general public by selling government bonds. The key difference between government bonds and money is that bonds are not 'capital-safe' in nominal terms: if there is a rise in the rate of interest, then the market value of the bond falls.

To understand the inverse relationship between the market price of a bond and the interest rate, consider a bond that is issued by the government at a face value of €100, and that pays €5 per annum in perpetuity. If the market interest rate is 4%, then the price the bond will sell for in the market (the market price) will be such as to make the yield of €5 represent a market return of 4%. The market value of the bond will be €x, where $0.04x = 5$; i.e., $x = 5/0.04 =$ €125. An interest rate lower than 5% implies a market value higher than the face value of the bond. If the interest rate is even lower at, say, 2%, then $x = 5/0.02 =$ €250 and similarly, if the interest rate is higher at, say 8%, then the market value is €62.50. There is an inverse relationship between the market value of the bond (i.e. the price at which it will sell in the market) and the market interest rate. It is clear that only if the interest rate is 5%, is the market value of the bond exactly equal to its face value. So unlike €100 in cash, the nominal market value of a €100 bond will go up whenever the nominal interest rate falls and vice versa.

3.1.2 Demand for money versus bonds

Consider the choice between holding one's assets in the form of money or in bonds, for example, from the perspective of a business deciding how to manage its cash. (As we shall see in Chapter 8, the discussion is not fundamentally different when additional assets such as equities are introduced.) Money is needed in order to carry out transactions in a market economy. Since desired transactions vary with the level of income, so will the demand for money. But the cost of holding assets in the form of money is that interest income is foregone. A rise in the interest rate will shift the balance of advantage in favour of interest-bearing assets including bonds.

We can summarize the demand for money as follows:

$$\frac{M^D}{P} = L(y, i), \qquad \text{(demand for money)}$$

where i is the *nominal* interest rate. We return to the question of the difference between the real interest rate, r, that features in the *IS* equation and the nominal interest, i, that features in the money market. We are dealing here with the 'L' part of the 'LM', where the 'L' refers to the demand for liquidity. A rise in the level of income, holding the interest rate unchanged, will raise the demand for money (i.e. $\partial L/\partial y > 0$) and a rise in the interest rate, holding the level of income unchanged will lower the demand for money (i.e. $\partial L/\partial i < 0$). Note that the demand for money is expressed in real terms i.e. (M/P) since it is normally assumed that a rise in the price level will raise the nominal demand for money in proportion.

Just as in the analysis of the goods market, it is sometimes helpful to express the demand for money as a linear function of the level of income and the interest rate:

$$\frac{M^D}{P} = L(y, i) = \underbrace{\bar{l} - l_i i}_{\text{asset demand}} + \underbrace{\frac{1}{v_T} \cdot y}_{\text{transactions demand}}, \qquad \text{(demand for money)}$$

where $\bar{l}, v_T$ and l_i are positive constants. The term $(\bar{l} - l_i i)$ reflects the asset motive for holding money and the term $(\frac{1}{v_T} \cdot y)$ reflects the transactions motive for holding money. In the famous theory called the Quantity Theory of Money, the only determinant of the demand for real money balances is the level of output. In other words, only the transactions motive is present. The Quantity Theory of Money can be stated as: $\frac{M^D}{P} = \frac{1}{v} \cdot y$, where v is the constant velocity of circulation. We use the now standard more general demand for money function in which the transactions demand is only one part of the demand for money. Hence, although the transactions velocity, v_T is constant, the overall relationship between money demand and output is not: it will vary with changes in the interest rate.

3.1.3 Asset and speculative motives

Two of the explanations given for the inverse relationship between the demand for money and the interest rate are known as the asset motive and the speculative motive. Both relate to the choice between holding money and bonds. Keynes argued for the relevance of the speculative motive as follows: if an individual believes that the current interest rate is above the level she considers normal, then she will expect the interest rate to fall to normal in due course. Under these circumstances, she will choose to hold financial assets over and above the money required for transactions in the form of bonds. She does this because she will expect to reap a capital gain on the bonds when the interest rate falls to its normal level. The converse would be true for a current interest rate believed to be below normal. Keynes believed that the subjective assessment of the normal interest rate would vary across the population, producing a smooth inverse relationship between the interest rate and the aggregate demand for speculative balances. Moreover a central implication of Keynes's argument is that expectations drive financial markets and that shifts in expectations have a self-fulfilling character. If bondholders suddenly believe that the interest rate will be higher in the future than they had previously believed, they will expect capital losses and will sell their bonds, driving bond prices down and interest rates up—the expectation of a rise in the interest rate is fulfilled. This feature of financial markets is of great importance for monetary policy.

A more general rationale for the negative dependence of the demand for money on the interest rate was developed by James Tobin in 1958. Instead of assuming, as had Keynes, that each individual is certain about what she expects the future rate of interest on bonds to be, Tobin focused on the implications of investor uncertainty. In the simplest version of Tobin's model, risk-averse[4] individuals allocate their portfolio between a riskless asset that pays no interest (money) and a risky one with a positive expected return (bonds). The individual's utility depends positively on the return from holding the asset and negatively on the risk of holding it. To maximize utility, the individual will hold a mixture of the two assets, trading off the benefits of a higher expected return against the associated risk according to her own preferences. A higher interest rate would lead her to substitute bonds for money (reduce the demand for money) because the higher expected return would offset the additional risk incurred. This produces an inverse relationship between the demand for money and the interest rate. A more detailed discussion of the speculative and asset motives can be found in Chapter 8.

3.2 Money market equilibrium

Money market equilibrium requires the demand and supply of money to be equal:

$$\frac{M^D}{P} = \frac{M^S}{P}, \qquad \text{(money market equilibrium)}$$
$$\text{money demand} = \text{money supply}$$

where the demand for money depends on the nominal interest rate and the level of output, as defined above, and the supply of money is assumed to be fixed by the monetary authorities at $\overline{M^S}$. In Chapter 8, we examine critically the assumption that the monetary authority can fix the supply of money; for now, we assume that this is possible. This assumption allows us to develop a useful benchmark model. If we substitute the demand for money function and the fixed money supply into the equilibrium condition,

$$L(y,i) = \frac{\overline{M^S}}{P}, \qquad \text{(money market equilibrium)}$$

we can define an upward sloping locus of money supply equal to money demand equilibria—the *LM* curve in the interest rate-output diagram.

The upward-sloping *LM* curve can be explained as follows. At a low level of income, the transactions demand for money is low because less money has to be held to finance

[4] Someone is risk averse if, when offered a fair bet, would refuse it; i.e., if offered the choice between receiving €100 with certainty or the chance of €200 (or zero) on the outcome of the toss of a fair coin, the individual would always take the certain €100. In other words, the individual prefers a *certain* value of €100 to an uncertain return with an *expected* value of €100.

transactions. Since the supply of money is fixed, for supply to equal demand in the money market, there must be a correspondingly high asset (or speculative) demand for money. A low interest rate will ensure this, since the returns from bondholding relative to the risks involved are low. The converse argument associates a high income level with a high interest rate.[5]

Using a linear demand for money function, there is a neat way of deriving the *LM* curve so that it is easy to see how shifts in the demand for money or changes in the interest sensitivity of the demand for money or changes in the money supply will affect the *LM* curve. The method is shown in Fig. 2.3 in two steps. Working through this diagram is a

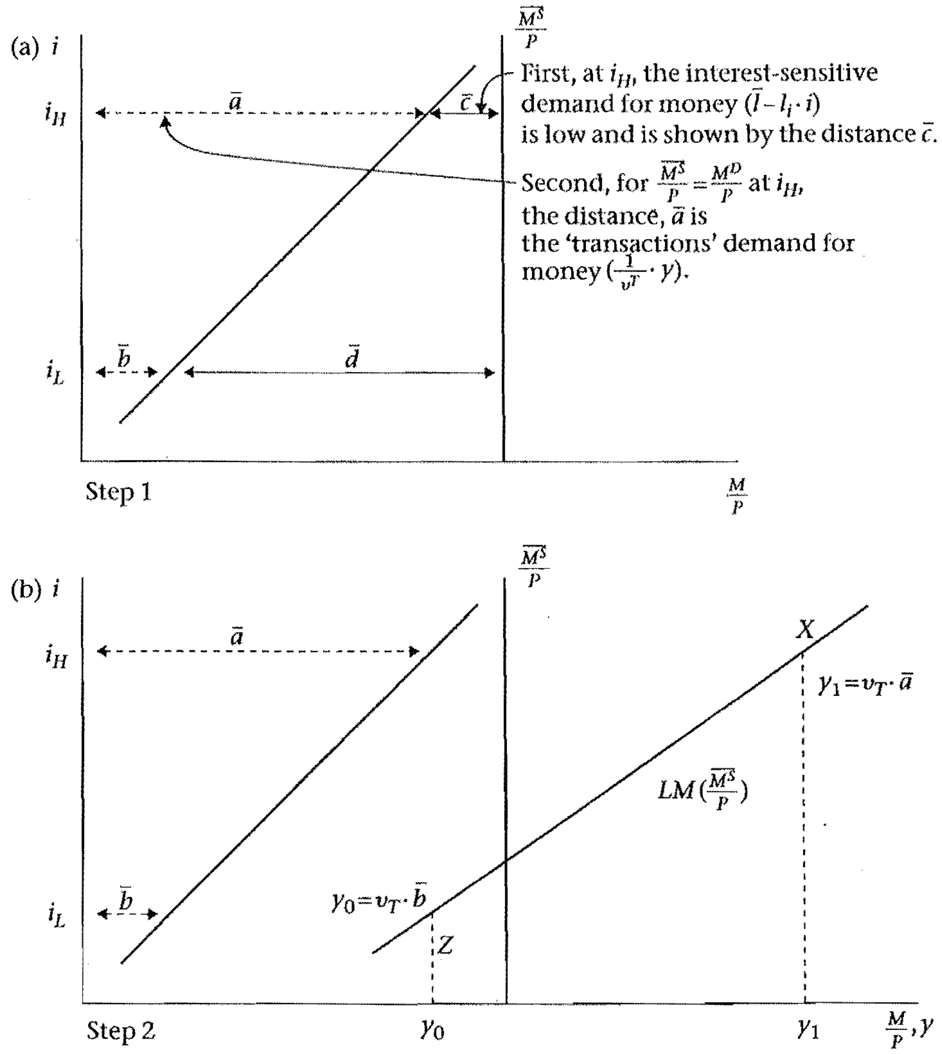

Figure 2.3 Deriving the *LM* curve

[5] The explicit form of the *LM* equation using the linear demand for money function is:

$$i = \frac{1}{l_i} \cdot \left(\bar{l} - \frac{\overline{M^S}}{P}\right) + \frac{1}{l_i} \cdot \frac{1}{v_T} \cdot y. \qquad \text{(LM equation)}$$

good method of securing your understanding of:

- the transactions demand for money and the role of v_T,
- the asset (or speculative) demand for money and the role of l_i;
- the role of the level of the money supply set by the central bank or the government, $\overline{M^S}$ and
- the equilibrium condition in the money market: $L = \frac{\overline{M^S}}{P}$.

In step 1, draw in the vertical real money supply line.[6] Now, draw in the interest-sensitive component of the demand for money 'backwards', i.e. relative to the money supply line as shown in Fig. 2.3. As we know, when the interest rate is high, the demand for money for asset purposes will be low (in the diagram, this is the distance $\bar{c}$). Now make use of the money market equilibrium condition: $\frac{\overline{M^S}}{P} = \bar{l} - l_i i + \frac{1}{v_T} \cdot y$. For money market equilibrium, asset demand for money $\left(\bar{l} - l_i i\right)$ plus the transactions demand for money $(\frac{1}{v_T} \cdot y)$ are equal to the money supply. Hence we can see how large the transactions demand for money must be for money market equilibrium at the interest rate i_H in Fig. 2.3. This is shown as the distance $\bar{a}$. Once we know the transactions demand for money that is associated with the interest rate, i_H, i.e. the distance $\bar{a}$, then since v_T is a constant, it is straightforward to take the second step of calculating the level of output, y, that is consistent with generating this demand for money: $y_1 = v_T \times$ (transaction demand for money at i_H). This fixes the level of output, y_1, at which the money market is in equilibrium when the interest rate is i_H: point X in the bottom panel. Point Y can be derived in the same way. By joining points X and Y the 'LM curve' is drawn.

From the derivation of the LM curve, there are four ways in which the position and/or the slope of the LM curve can be affected.

(1) A change in the *transactions velocity of circulation*. The transactions velocity of circulation, v_T, is the constant reflecting the proportional relationship between income and the demand for *transactions* balances. It is the number of units of income that one unit of transactions balances can finance. Any rise in the transactions velocity as the result of financial innovation (e.g. introduction of credit cards, development of non-bank financial institutions) will rotate the LM to the right (clockwise), making it flatter.

(2) A change in the *interest sensitivity of the asset demand for money*, l_i. A more interest-sensitive demand for money, reflecting the fact that small changes in the interest rate will have large effects on the portfolio mix between money and bonds, will produce a flatter LM curve.

- A special case arises when the interest-sensitive demand for money becomes perfectly elastic, in which case, the LM curve becomes horizontal. The simplest interpretation of this is in terms of speculative demand: if it is the case that no one believes that the normal interest rate is lower than the actual interest rate, $\hat{\imath}$, then the speculative demand for money is perfectly elastic at $\hat{\imath}$ because nobody is prepared to use spare cash

[6] If you want to see what happens if the *supply* of money is also sensitive to the interest rate, you can modify the method at this point.

balances to further bid up the bond price. Under such conditions, the interest rate is so low that everyone believes it will rise to its normal level (opinions will differ on what that normal level is). In Fig. 2.3, if $\hat{\imath} = i_L$, the interest-sensitive money demand and the *LM* curves would turn horizontal at i_L. This is the famous 'liquidity trap' case, to which we return at the end of section 4.2 (see Fig. 2.6).

(3) A change in the *money supply*. An increase in the money supply will shift the *LM* curve to the right, since at any interest rate, with a given asset demand for money, a higher money supply will require higher transactions balances to bring money demand into line with the higher supply. A higher output level will generate the higher transactions demand.

(4) A change in the *price level*. For a given interest rate, with a higher price level, the available transactions balances can only finance a lower amount of output. The *LM* curve shifts to the left.

The simple mathematics and geometry of the *LM* curve required to specify statements 1–4 are presented in the Appendix to this chapter.

At a point such as *X* above the *LM* curve in Fig. 2.4, with the output level, y_0 and interest rate i_X, money balances are too high for money market equilibrium. We can see that the disequilibrium could be eliminated either by a rise in the level of output or by a fall in the interest rate. When there is excess supply of money (excess demand for bonds), the excess money balances are channelled into the bond market, the bond price is bid up, and the interest rate reduced (recall the earlier discussion of the inverse relationship between the interest rate and the price of bonds). The converse situation of excess demand for money is true of a point such as *Z* below the *LM* curve. This will be cleared by the sale of bonds, which pushes down the bond price and raises the interest rate.

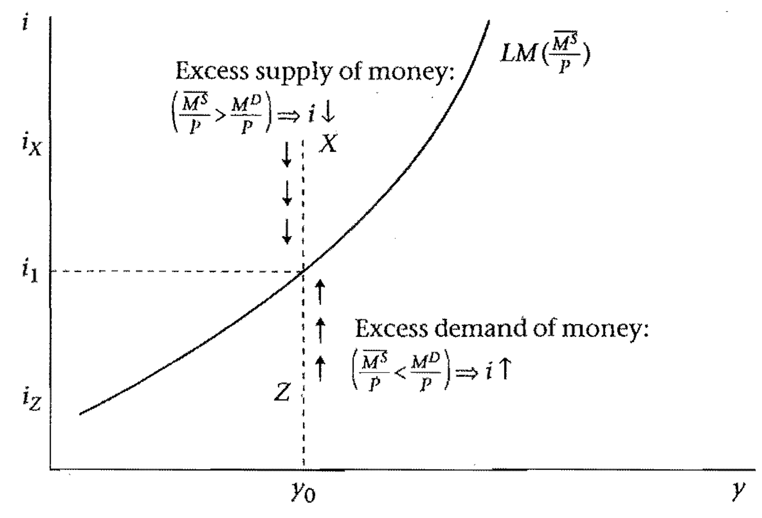

Figure 2.4 Adjustment to money market equilibrium; excess supply of money at point *X* leads to a fall in the nominal interest rate, excess demand for money at point *Z* leads to a rise in the nominal interest rate

4 Putting together the *IS* and the *LM*

By combining the goods and money markets, the interest rate and the short-run equilibrium level of output for a given price level are determined. Before that, there is one tricky problem that needs to be addressed. In the derivation of the *IS* curve, it is the *real* interest rate, r, that is relevant since investment spending depends on the real rate of interest. In the derivation of the *LM* curve, it is the *nominal* interest rate, i, that is relevant since the demand for money depends on the nominal interest rate.

4.1 Real and nominal interest rates

To clarify why it is the real rather than the nominal interest rate that affects real expenditure decisions in the economy, think about a firm considering an investment project. A higher money or nominal rate of interest will not impose a greater real burden on the firm if it is balanced by correspondingly higher inflation because the expected profits from the investment project will be higher in money terms and the balance between the real cost and the real return on the project will not have changed.

The real interest rate is defined in terms of *goods* and the nominal interest rate, in terms of *money*. Thinking of a consumer good, the real rate of interest, r, is how much extra in terms of this good would have to be paid in the future in order to have one of the goods today: 1 $\text{good}_t = (1 + r)\text{good}_{t+1}$, where the subscript t refers to today and $t + 1$ to one period later. The nominal rate of interest is how much extra in euros would have to be paid in the future in order to have one euro today: $1 \text{€}_t = (1+i)\text{€}_{t+1}$. If goods prices remain constant then it is clear that the real and nominal interest rates are the same: if you lent one euro today, you would be able to buy $(1 + r)$ goods in the future. In general,

$$1 + r = (1 + i) \cdot \frac{P}{P^E_{t+1}},$$

where it is the expected price level in the future (P^E_{t+1}) that comes into play since at time t, we do not know what the price level will be at $t + 1$. If we use the following definition of expected inflation:

$$\pi^E = \frac{P^E_{t+1} - P}{P},$$

then

$$\frac{P}{P^E_{t+1}} = \frac{1}{1 + \pi^E}.$$

By rearranging the above expression, it follows that

$$(1 + r) = \frac{(1 + i)}{(1 + \pi^E)}$$

and therefore that

$$r = \frac{i - \pi^E}{1 + \pi^E}.$$

When expected inflation is low, the denominator of this expression is close to 1 and we have the standard approximation for the relationship between the real and the nominal rate of interest:

$$i \approx r + \pi^E.$$

Inflation expectations will drive the divergence between the real and nominal interest rates. It should be noted that only one of these three terms is observable: the nominal interest rate, i. The real interest rate can be estimated from historical data on the nominal interest rate and the rate of inflation: this gives a measure of the so-called *ex post* real rate of interest. Alternatively, an *ex ante* measure can be derived from a model that is able to predict inflation. Finally, if bonds have been issued in the economy that are protected against inflation because the face value is indexed by the rate of inflation, then the yield on such a bond is a real rate of interest and can provide a third measure. But there are only a few countries that have issued index-linked or inflation-proof bonds (UK in 1981, the USA in 1997, France in 1998).

4.2 The *IS/LM* model

So as to avoid (temporarily) the problem of the *IS* depending on the real and the *LM* on the nominal interest rate we concentrate on how the *IS/LM* model works when the real and nominal rates are identical. This requires us to assume that inflation is zero and is expected to remain so. To remind us that two different interest rate concepts are involved, we draw the *IS/LM* diagram with both 'r' and 'i' on the vertical axis. We shall return to show how to amend the *IS/LM* model when inflation is different from zero in Chapter 3.

Now that both the *IS* and the *LM* relationships have been derived, the short-run equilibrium interest rate and level of output will be determined by the intersection of the two curves. To see how the *IS/LM* model works, the initial *IS/LM* equilibrium is disturbed by changing one of the exogenous variables. First, we consider the character of the new short-run equilibrium and as a second, we discuss the likely adjustment of the economy to it. The path of adjustment of the economy in the face of a disturbance will depend on the speed of adjustment in each market. The most plausible simple assumption is that money market disequilibria are cleared very rapidly in relation to disequilibria in the goods and services market. In the *IS/LM* diagram, this means that the economy returns to the relevant *LM* curve rapidly—the adjustment occurs through changes in the price of bonds in the financial markets and therefore in market interest rates. Goods market adjustment takes place less quickly since it involves adjustments to production and employment.

We look at two examples of government policy changes. In the first example (Fig. 2.5), government spending rises. The new *IS* is $IS(g_1)$ to the right of the original one. The new short-run equilibrium is at the point A': output is higher and so is the interest rate. Higher government spending will generate higher aggregate demand and a higher output level.

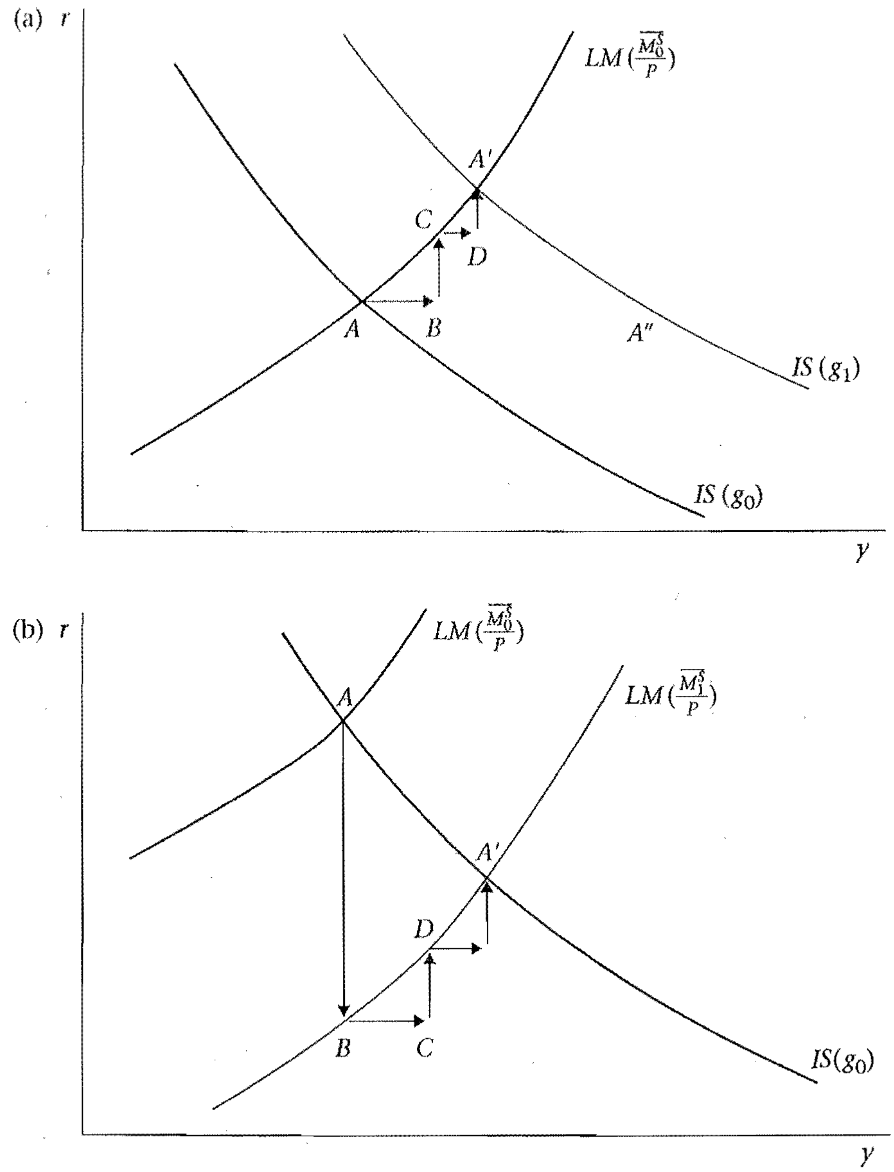

Figure 2.5 Comparative statics in the *IS/LM* model: sluggish adjustment in the goods market and rapid adjustment in the money market
(a) Fiscal policy: rise in government spending
(b) Monetary policy: rise in the money supply

Higher incomes will mean a higher demand for money but since monetary policy is unchanged (i.e. the *LM* curve remains fixed), a higher interest rate will be required in the new equilibrium to dampen the asset demand for money.

Let us now think about the likely process of adjustment to the new equilibrium. In the first instance, the rise in government spending produces excess demand for goods and results in unplanned inventory decumulation or in longer waiting times for services. If the rise in demand is sustained, then employment is increased. The economy moves from *A* to *B*. The rise in real income associated with higher output boosts the transactions demand for money, with the result that there is excess demand for money balances at B. Bonds are sold, causing the bond price to fall and the interest rate to rise (B to C). The rise in the interest rate dampens the excess demand for goods by reducing investment demand; nevertheless, at C there remains excess demand owing to increased consumption associated with the multiplier effects of the rise in government spending. Output and employment rise further (C to D). The adjustment process continues until the new equilibrium at A' is attained. The full multiplier expansion of output (A to A'') does not occur because when there is a fiscal expansion without any change in the money supply, the increase in the interest rate causes a fall in interest-sensitive spending. The implications of financing an increase in government expenditure by (i) taxation, (ii) bond finance as in the above example, and (iii) money finance are compared using the *IS/LM* model in Chapter 6.

In the second example (Fig. 2.5), the government or central bank increases the money supply through the use of open market operations. This means that it enters the money market purchasing bonds in exchange for newly printed money. The *LM* curve shifts to the right to $LM(\frac{\overline{M_1^S}}{P})$. Once again, we first consider the new short-run equilibrium which has a higher level of output and a lower interest rate. With a higher money supply, the higher demand for money in the new equilibrium will require a lower interest rate. A lower interest rate will be associated with a higher level of investment and output (point A' in the lower panel of (Fig. 2.5)).

We turn now to the adjustment from point A to the new short-run equilibrium at A'. The immediate effect of the monetary authority's action is to create excess supply of money; the implied excess demand for bonds raises bond prices and lowers the interest rate. The economy moves from A to B, immediately attaining the new money market equilibrium along $LM(\frac{\overline{M_1^S}}{P})$. The fall in the interest rate creates excess demand in the goods market by stimulating investment. Higher investment demand pushes up output and employment; raising output from B to C. At C, there is once again money market disequilibrium as excess *demand* for money accompanies the rise in output. The interest rate rises (C to D). Adjustment of output and the interest rate will continue until the new equilibrium at A' is reached.

Fig. 2.6 shows why expansionary monetary policy may not raise output even in the short run. If the interest rate is $\hat{i}$, the *LM* curve is flat. When the central bank enters the money market to purchase bonds, there is no impact on the price of bonds: if everyone believes the only direction for the interest rate in the future is up, this implies they believe that bond prices will fall. Bondholders therefore willingly sell bonds at the existing price, being indifferent between money and bonds as the prospective capital loss on bonds just offsets the interest received, with the result that there is no rise in the bond price and no fall in the interest rate. The economy is in a liquidity trap where new money pumped into the economy is willingly held as money balances. The central bank is therefore powerless to use monetary policy to shift the economy to a higher level of output. For decades the case of the liquidity trap was viewed as a theoretical possibility with little practical relevance but the re-emergence of an era with very low nominal interest rates in the 1990s has revived interest in it. Since the nominal interest rate cannot fall below zero, the notion that everyone believes the interest rate will rise becomes plausible. The liquidity trap plays a role in the analysis of the long Japanese slump in the 1990s and is discussed further in Chapters 5 and 17.

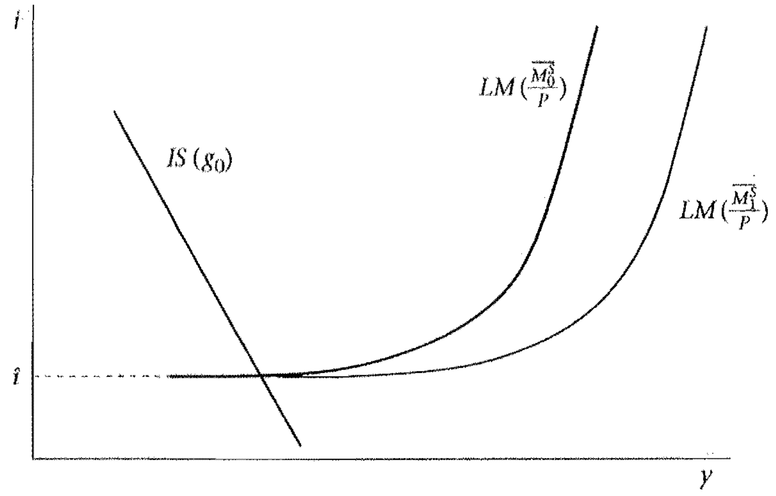

Figure 2.6 The liquidity trap

5 Aggregate supply

We turn now to setting out systematically the structure of the supply side of the economy that will be used to create an integrated short- and medium-run model. We begin by noting briefly how the supply side looks in a competitive model before moving to the more general model of imperfect competition with which we mainly work.

5.1 Equilibrium in the competitive labour market

In the competitive labour market the demand for labour and the supply of labour depend on the real wage. The downward-sloping labour demand curve shows the labour demanded at a given real wage. With a fixed capital stock, as we assume is the case in the short and medium run, output is a positive function of the level of employment, i.e.

$$y = f(E),$$

where f is the short- (and medium-) run production function. The standard assumption is that the production function is characterized by diminishing returns, which means that as more workers are employed, the increment in output declines. In short, the marginal product of labour, which can be written as $\frac{\partial y}{\partial E}$ or *MPL* declines as employment rises. The labour demand curve 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 real wage.

The supply of labour is upward sloping and is derived from the optimizing behaviour of households as they allocate their time between work and leisure to maximize their utility. The real wage is taken as given and the worker chooses the amount of labour to supply.

In a competitive labour market, the market clears, establishing the market-clearing real wage and level of employment. This is shown in Fig. 2.7 with the real wage w_0 and employment, E_{CE} (for Competitive Equilibrium). Any temporary displacement of the economy

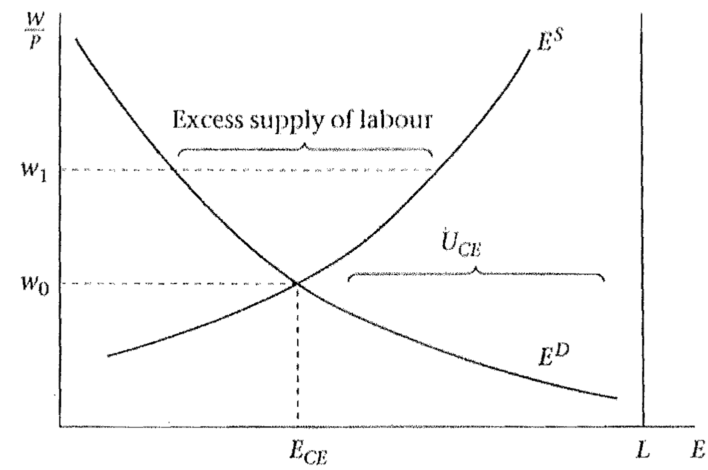

Figure 2.7 Equilibrium in the competitive labour market: equilibrium values of the real wage and employment

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 money wages until the unique competitive equilibrium is re-established with the real wage at w_0 and employment at E_{CE}. 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 obtainable through working. In Fig. 2.7, the labour force, which can be thought of as the maximum amount of labour that could be supplied, is shown by the vertical line. The competitive equilibrium rate of unemployment is U_{CE}/L, where L is the labour force, i.e. the sum of the employed and the unemployed. It is important to remember that the economy is at a welfare optimum in the competitive 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.

6 Supply side in the imperfect competition model

A major task of macroeconomics is to analyse the causes and consequences of *involuntary* unemployment. Unless there are imperfections in the labour market, it is not possible for there to be involuntary unemployment when the labour market is in equilibrium, since wages would fall to clear the market. This is prevented in an imperfectly competitive labour market in which the wage is set either by employers, by unions, or as a result of bargaining between employer and union. Labour is not bought and sold in a spot market (like wheat); there are wage contracts that set the wage above the market-clearing level. As we have seen in Chapter 1, collective bargaining affects wage setting for a substantial proportion of workers in most OECD countries (see Appendix Table 4.1, Chapter 4 for the extent to which workers' wages are covered by collective bargaining in the full list of OECD countries.) Even in the absence of unions, problems of motivating workers to work efficiently mean that wages are set by employers above the market-clearing level. In imperfectly competitive product markets, firms set prices with a mark-up over their costs. The real wage is therefore the outcome of wage- and price-setting decisions across the economy. In an open economy model, the price level of imports will also affect wage and price setting but this issue is not addressed until later. The first section of Chapter 10 can be read in parallel with this section to see how the openness of the economy affects wage setting, price setting, and equilibrium unemployment. In the imperfect competition model, the *ERU* is the unemployment rate at which the real wage is consistent with the real wage expectations of both wage and price setters.

6.1 Wage setting

Under imperfect competition, there is an upward-sloping wage setting (*WS*) curve that is the counterpart of the labour supply curve in the competitive model. Because of labour market imperfections, the wage setting curve lies above the labour supply curve. In Fig. 2.8, if the real wage is equal to w_1, then the competitive labour supply is E_1. But with labour market imperfections, w_1 will be set at the lower level of employment, E_0 despite the fact that an additional number of workers ($E_1 - E_0$) would be prepared to work at that wage. Similarly, if $E = E_0$, then this supply of labour is consistent with a real wage of w_0, but under imperfect competition, a higher wage, w_1, is set at that level of employment.

Conditions in the labour market are the key determinant of the 'wage setting real wage'. In terms of money wages, the wage setting equation is

$$W = P \cdot b(E) \qquad \text{(wage equation)}$$

where P is the price level, E is the level of employment and b is a rising function of employment. When wages are set by unions, employers, or through bargaining, it is the

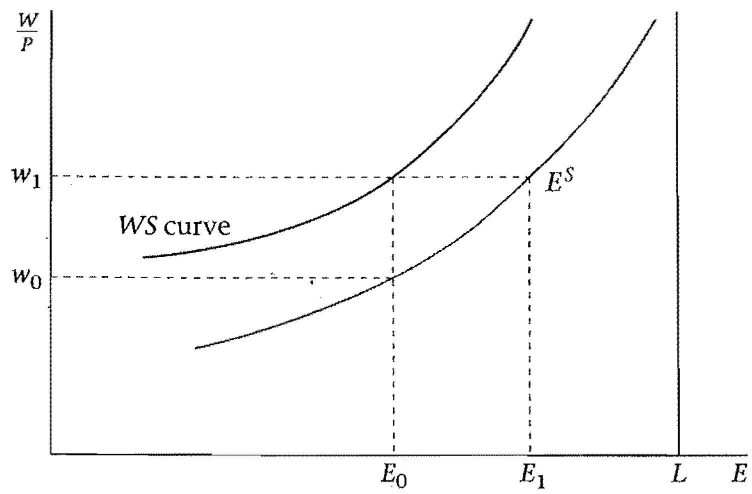

Figure 2.8 The wage setting real wage curve: *WS* curve and the labour supply curve

nominal (i.e. money) wage that is fixed. However, workers will evaluate wage offers in terms of the *real* wage that they are expected to deliver—i.e. it is the money wage relative to the expected consumer price level that affects the standard of living and hence the worker's utility.

Assuming that the actual and expected price level are equal, the wage equation can be written in terms of real wages to define the upward-sloping wage-setting curve in the labour market diagram (see Fig. 2.8):

$$w^{WS} = b(E), \qquad \text{(wage-setting real wage)}$$

where $w^{WS} \equiv W/P$.

The excess of the real wage on the *WS* curve above that on the labour supply curve at any level of employment is the mark-up per worker (in real terms) associated with labour market imperfections.

Two common interpretations of this mark-up, both relying on imperfect competition, are

(1) wage setting by unions and

(2) efficiency wage setting by firms.

6.1.1 Wage setting by 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 employment and (ii) too low a wage, which will fail to use the union's monopoly power to secure better living standards. This results in the union setting a wage at a given employment level that is higher than the competitive wage (the difference is referred to as the union wage mark-up) and produces a positively sloped wage setting curve that lies above the competitive labour supply curve. The details of how to derive the wage setting curve in the monopoly union model are set out graphically in Chapter 4 and in more detail in Chapter 15.

6.1.2 Efficiency wage setting by firms

Efficiency wage setting is quite different: here it is firms that set wages. At first sight, it is counter-intuitive that an employer should voluntarily set a wage above the minimum at which it can hire labour in the market. The argument is that by setting a wage above the competitive one, the employer is able to retain a well-qualified and cooperative workforce. The term 'efficiency' wages arises from the notion that the firm sets a wage that allows it to efficiently solve its motivation, recruitment, and/or retention problems. These problems arise because it is generally not possible to specify fully what a worker does, i.e. the employer cannot observe accurately the worker's effort. The employer must therefore use the wage to motivate the worker to perform well. As the labour market tightens, i.e. as unemployment falls, it becomes more difficult for the firm to solve these problems because workers can easily leave the firm and find work elsewhere. The result is that the employer sets a wage above the competitive wage and this 'efficiency' wage rises as unemployment falls. This is therefore a second way of understanding the wage setting curve. The details of how to derive the wage setting curve in efficiency wage models can be found in the appendix to Chapter 15 and can be understood without reading the rest of Chapter 15.

6.2 Price setting

Under perfect competition, the real wage implied by competitive pricing by firms is the marginal product of labour (or labour demand) curve. Firms take the market price, P, and set it equal to their marginal cost:

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

By contrast, under imperfect competition, firms set a price to maximize profits. The mark-up on marginal cost will depend on the elasticity of demand: 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.

If we take the simplest case of monopoly, then profits are maximized when marginal revenue is equal to marginal cost. If the (absolute value of the) elasticity of demand (ϵ, called epsilon) is constant, then there is a constant mark-up greater than one of $\frac{\epsilon}{\epsilon-1}$ and we have the standard monopoly pricing formula:

$$P = \frac{\epsilon}{\epsilon - 1} \cdot \frac{W}{MPL}$$

and the price-setting real wage is:

$$\frac{W}{P} = \frac{\epsilon - 1}{\epsilon} \cdot MPL.$$

Fig. 2.9 illustrates the *PS* curve in the monopoly case: because $\frac{\epsilon-1}{\epsilon} < 1$, the price-setting real wage is a fraction of the marginal product of labour.

More generally, any type of product market imperfection causes the *PS* curve to lie below the competitive labour demand curve. 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 the imperfect competition in the product market.

We shall 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

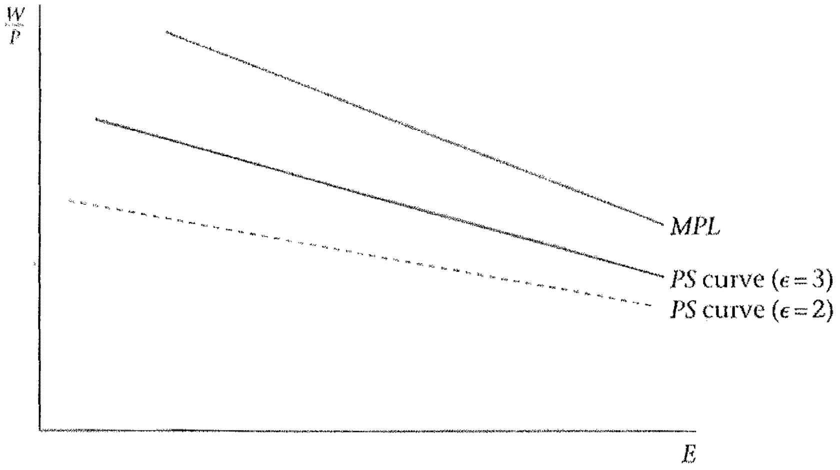

Figure 2.9 Relationship between the *MPL*, the price elasticity of demand, and the *PS* curve

horizontal *PS* curve. Additional assumptions are required. Three alternatives are:

- 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.
- if the marginal product of labour declines but the mark-up is counter-cyclical (i.e. the mark-up shrinks as employment rises) then the *PS* curve will flatten. The mark-up would be counter-cyclical if for example, new entry was encouraged by a boom, heightening product market competition.
- 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 cost associated with changes in demand. Frequent price changes in response to changes in demand are costly in themselves (these are the so-called menu costs of price changes) and firms may also wish to avoid them for strategic reasons.

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. The flat *PS* curve offers a useful simplification because it implies that firms do not change their prices in response to fluctuations in output (in line with our assumption of sticky prices in the short run); rather, they change their prices only when their costs change, e.g. as a consequence of a change in wages. On the reasonable assumption that wage changes occur relatively infrequently (e.g. at the annual wage round or the periodic wage review in the case of individual contracts), it is wage changes that provide the natural trigger for the end of the short run in the model.

In this baseline case, we use simple assumptions to deliver a flat *PS* curve: a constant marginal product 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, $\widehat{\mu}$ (pronounced 'mew' hat) on unit labour costs,

$$P = (1 + \widehat{\mu})\left(\frac{W}{\lambda}\right), \qquad \text{(mark-up pricing rule)}$$

where unit labour costs are the cost of labour per unit of output i.e. $W \times E$ divided by y. We define $\frac{y}{E}$ (output per worker) as λ (lambda, labour productivity).

It is handy to express the mark-up in a slightly different way when setting up the macro model. If we let $\mu = \widehat{\mu}/(1 + \widehat{\mu})$, then the pricing equation can be written as

$$P = \frac{1}{1-\mu} \cdot \frac{W}{\lambda}, \qquad \text{(price-setting equation)}$$

where we refer to μ as the mark-up from now on. This means that as the extent of competition faced by the firm increases, the size of the mark-up falls. Dividing each side by P and rearranging, gives

$$\lambda = \mu \cdot \lambda + \frac{W}{P}.$$

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

In other words, given the mark-up, the level of labour productivity, and the money wage, the price level set by firms implies a specific value of the real wage. This is the price-setting real wage (see Fig. 2.10):

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

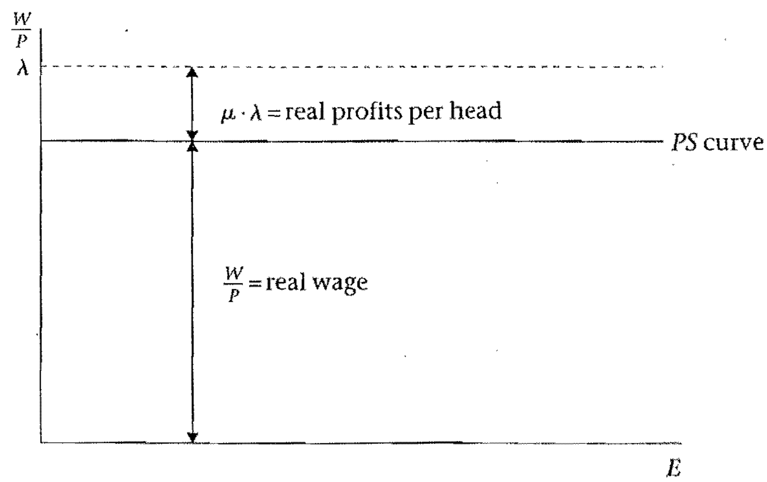

Figure 2.10 The price-setting real wage curve: PS curve

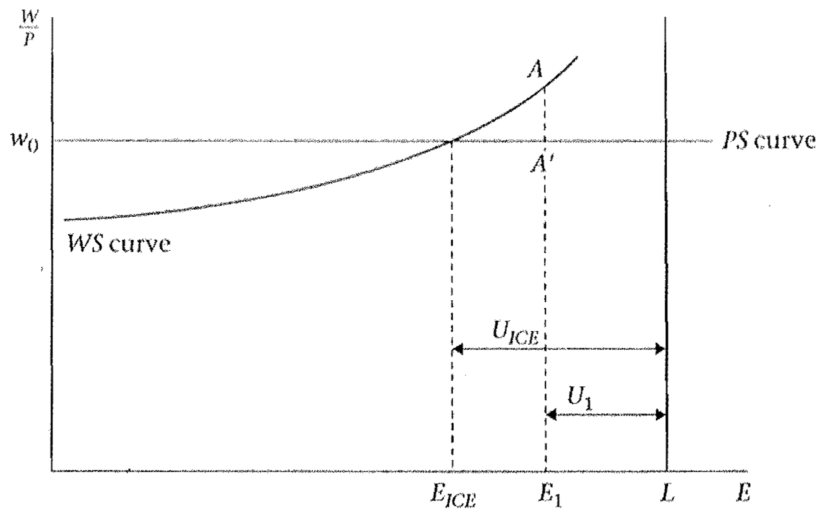

Figure 2.11 Equilibrium employment and unemployment: U_{ICE} and E_{ICE}

6.3 Equilibrium in the labour market under imperfect competition

The labour market under imperfect competition 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. 2.11):

$$w^{WS} = w^{PS}$$
$$b(E) = \lambda \cdot (1 - \mu),$$

(labour market equilibrium, imperfect competition)

and defines the unique equilibrium level of employment E_{ICE}, where $_{ICE}$ stands for 'imperfect competition equilibrium'. The associated equilibrium rate of unemployment (the *ERU*) is U_{ICE}/L, where L is the labour force.

The assumption that prices are set straight after wages (i.e. without a lag) means that the real wage is always on the *PS* curve whereas as noted above, workers are on the *WS* curve believing that the current price level is at its expected level. To take an example, suppose that employment rises to E_1 as a consequence of an expansionary fiscal policy. At the next wage setting round, this provokes a money wage rise as wage setters aim for point A. However, the immediate adjustment of prices to the cost increase means that prices rise in line with the wage increase and the economy moves to point A'. The timing assumption means that the economy is normally on the *PS* curve; if $P > P^E$, workers will be on the *PS* curve to the right of the equilibrium and if $P < P^E$, they will be on the *PS* curve to the left of the equilibrium. It follows that if lags in price setting were introduced, the real wage would lie in between the *WS* and *PS* curves.

The contrast between the competitive and imperfectly competitive equilibrium rates of unemployment is shown in Fig. 2.12, which superimposes the *WS* and *PS* curves on the labour market diagram showing the competitive labour supply and marginal product of labour curves. The *WS* curve lies above the labour supply curve to reflect the market imperfection. Similarly, the *PS* curve lies beneath the marginal product of labour curve

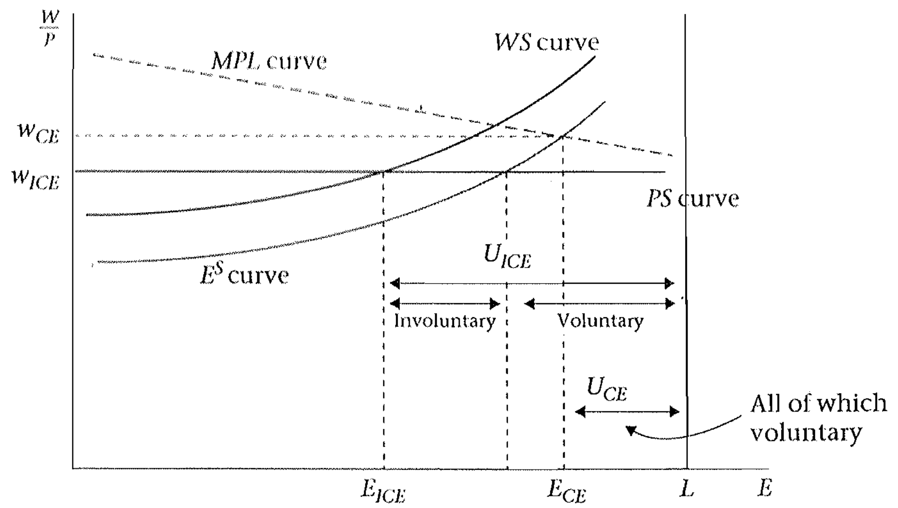

Figure 2.12 Concepts of unemployment

if there is imperfect competition in the product market: with firms making supernormal profits, workers will be paid less than their marginal product.

If the labour market is imperfectly competitive, unemployment at the *ERU* (equilibrium rate of unemployment) will necessarily include some involuntary unemployment. In other words, there will be individuals prepared to take a job at the going real wage who are unable to find a vacancy. How do we know this? The labour supply curve indicates the real wage at which an individual is prepared to work. Since the labour supply curve lies beneath the wage setting curve, we know that there are people who would be willing to work at the real wage, w_{ICE}, who are not employed when employment is at its equilibrium level, E_{ICE}.

Since there is involuntary unemployment at U_{ICE}, it is not the 'ideal' rate from a welfare perspective. Rather, given the institutions and practices in the economy that lie behind the wage and price setting curves, the *ERU* is the unemployment rate that constitutes an equilibrium in the sense that wage and price setters have no reason to change their behaviour. The split between involuntary and voluntary unemployment in the imperfect competition model is shown in the diagram.[7]

The equilibrium rate of unemployment is the outcome of 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. For example, changes in legislation to weaken trade unions could lead to a reduction of union bargaining power and this would lower the expected real wage that could be negotiated by workers at any level of unemployment, lowering $b(E)$ and shifting the *WS* curve down. Holding all other features of the economy constant, this would lower the equilibrium rate of unemployment. Alternatively, 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

[7] For a recent exploration of different concepts of unemployment, see de Vroey (2004*a*). A summary can be found in de Vroey (2004*b*).

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 unemployment benefits, 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 in Chapter 4.

7 Aggregate demand and aggregate supply

In many presentations of short- and medium-run macroeconomics, the two components of aggregate demand and supply are brought together using a diagram with the price level on the vertical axis and output on the horizontal one. We shall not make extensive use of this diagram in this book because it is not a particularly good way of analysing shocks and policy responses. However, it does serve a couple of useful purposes: first, it provides a simple way of seeing how the price level is determined and second it provides another lens through which macro models can be compared.

7.1 Aggregate demand: from the *IS/LM* diagram to the *AD* curve

The goods and money market equilibrium conditions can be transfered to a diagram with the price level on the vertical axis and output on the horizontal axis. In the top panel of Fig. 2.13, the economy begins at point *A*. (Note that the *LM* curve is indexed by the real money supply: $\frac{\overline{M^s}}{P_1}$, which means that the position of the *LM* curve is fixed by the real money supply defined by $\frac{\overline{M^s}}{P_1}$.) Next, we hold the nominal money supply constant and lower the price level to P_0: the new money market equilibrium is shown by $LM(\frac{\overline{M^s}}{P_0})$. The increase in the value of the real money balances in the hands of the public creates disequilibrium in the money market: with 'too much money', households rebalance their portfolios by buying bonds. This pushes up the bond price and lowers the interest rate. This is known as the 'Keynes effect'. The new equilibrium is at point *B* with higher output. The equilibria at *A* and *B* are mapped into the diagram beneath with *P* on the vertical and *y* on the horizontal axis. The combined goods and money market equilibria for different price levels produce the *AD* curve as shown. It follows from this derivation that anything that shifts the *IS* or *LM* curves, apart from a change in the price level, shifts the *AD* curve.

The *AD* curve has a completely different character from a demand curve in a microeconomic market, where the demand curve relates the quantity demanded to the price of a particular commodity.[8] By contrast, the *AD* curve represents two sets of equilibrium conditions. When the price level *P* changes, it disturbs the equilibrium in the money market, which triggers a change in behaviour that leads the interest rate to change. This in

[8] Why does a lower price level *not* mean that people are better off and therefore buy more? The fallacy in this argument is that a lower general price level implies lower money incomes in the economy since these make up the price level. Hence a lower price level does not imply higher real incomes and spending.

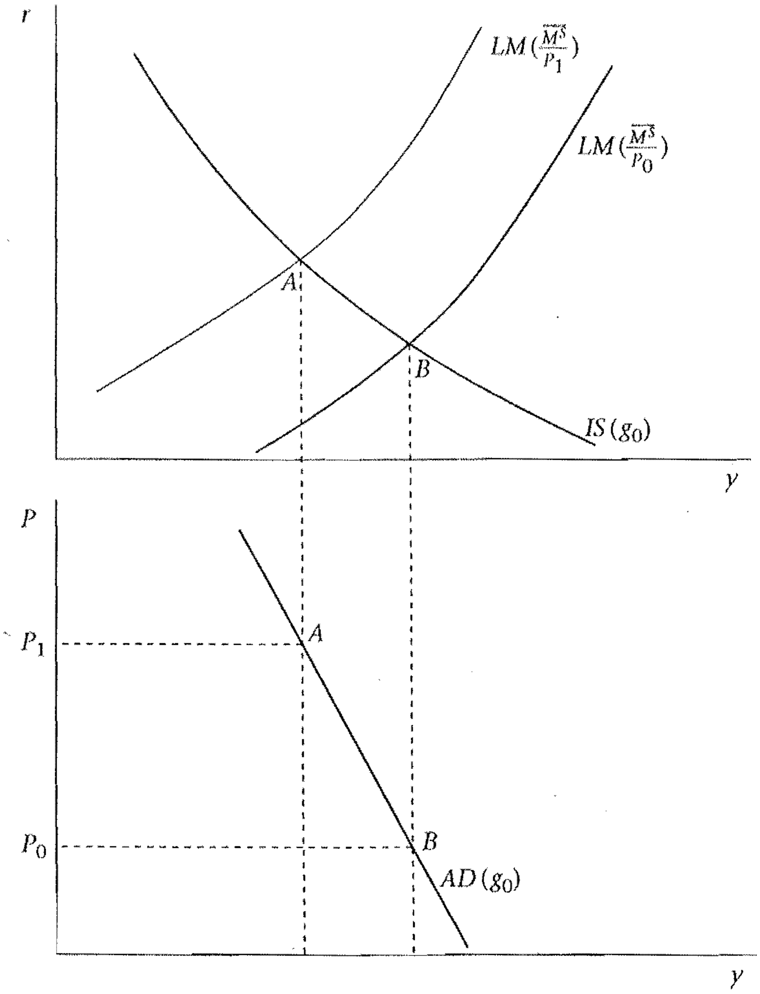

Figure 2.13 Deriving the *AD* curve

turn creates a disequilibrium in the goods market and output changes as equilibrium is restored.

We have already encountered indirectly the case in which a fall in the price level is *not* associated with a rise in output: the liquidity trap. If the *LM* curve is horizontal, then a fall in *P* shifts the horizontal section of the *LM* to the right and the interest rate does not change. The reason is that households are happy to hold on to the higher real money balances because they believe that the interest rate can fall no further. Under such circumstances, falling prices fail to stimulate the economy. This is one way of interpreting the Japanese slump in the early 2000s.

When Keynes argued for the relevance of the liquidity trap in the 1930s, some economists responded by claiming that even if the interest rate did not respond to a fall in the price level, there was another route to the revival of demand. The so-called Pigou effect depends on the response of consumption to changes in real wealth. If the Pigou effect is at work, falling prices raise real wealth and stimulate consumption thereby restoring the downward slope to the *AD* curve. But there seems to be a reverse

Pigou effect at work in Japan, where it is reported that falling prices leads consumers to hoard money in the expectation that prices will fall even further: consumption is postponed and not boosted.

7.2 Aggregate supply: from the labour market diagram to the *AS* curve

Information about the labour market equilibrium can also be transferred into the so-called *AD-AS* diagram. In both the competitive and imperfectly competitive models, there is a unique employment level consistent with labour market equilibrium. The short-run production function is used to convert that level of employment into the medium-run equilibrium level of output. Since the labour market equilibrium is defined in real terms, changes in the price level do not affect the equilibrium.

The aggregate supply curve is therefore vertical at y_{CE} or y_{ICE}, which is at the output level y_0 in Fig. 2.14. The diagram can be interpreted as representing either the competitive or the imperfectly competitive case. A rightward shift in the aggregate demand curve because of a rise in autonomous consumption, for example, would be associated with labour market equilibrium only at the unchanged y_{CE} or y_{ICE}. If the price level jumps up as shown in Fig. 2.14, then the economy moves straight from *A* to *Z*.

This special case of the immediate adjustment of wages and prices is summarized by the *AD* curve combined with a vertical *AS* curve. An economy of this kind experiences fluctuations in output only as a consequence of changes on the supply-side since fluctuations in aggregate demand shift the *AD* curve (e.g. fiscal policy, monetary policy, or private sector shocks), which affects the price level but not output and employment. We return to Fig. 2.14 below, but first, we look more closely at a model of business cycles where they are driven by the supply side.

7.3 Two approaches to business cycles

7.3.1 The Real Business Cycle model: supply shocks

The idea that the fluctuations in employment that we observe in the economy as it moves from recession to boom and back again are due purely to supply-side factors rather than to fluctuations in aggregate demand is central to the so-called Real Business Cycle (RBC) model.[9] In this model, the labour market is *always* in equilibrium. We shall see that this contrasts with the situation in a model in which the business cycle is driven by fluctuations in aggregate demand where in a boom, employment is above the equilibrium and in a recession, employment is below it. In the RBC model, it is supply-side factors such as changes in technology that drive the business cycle. To see how this works, we assume that in Fig. 2.15, the economy is initially at point *A*. A positive technology shock such as a wave of innovation, then shifts the marginal product of labour curve to the right (to MPL_H) and the economy moves to point *B*: this is a boom. The opportunity for workers to earn higher wages as a consequence of the new technology, leads them to

[9] The Nobel Prize in economics in 2004 was awarded to the economists that developed the real business cycle approach: Finn Kydland and Edward C. Prescott. Their prize lectures and other useful material can be found at: http://nobelprize.org/economics/laureates/2004/.

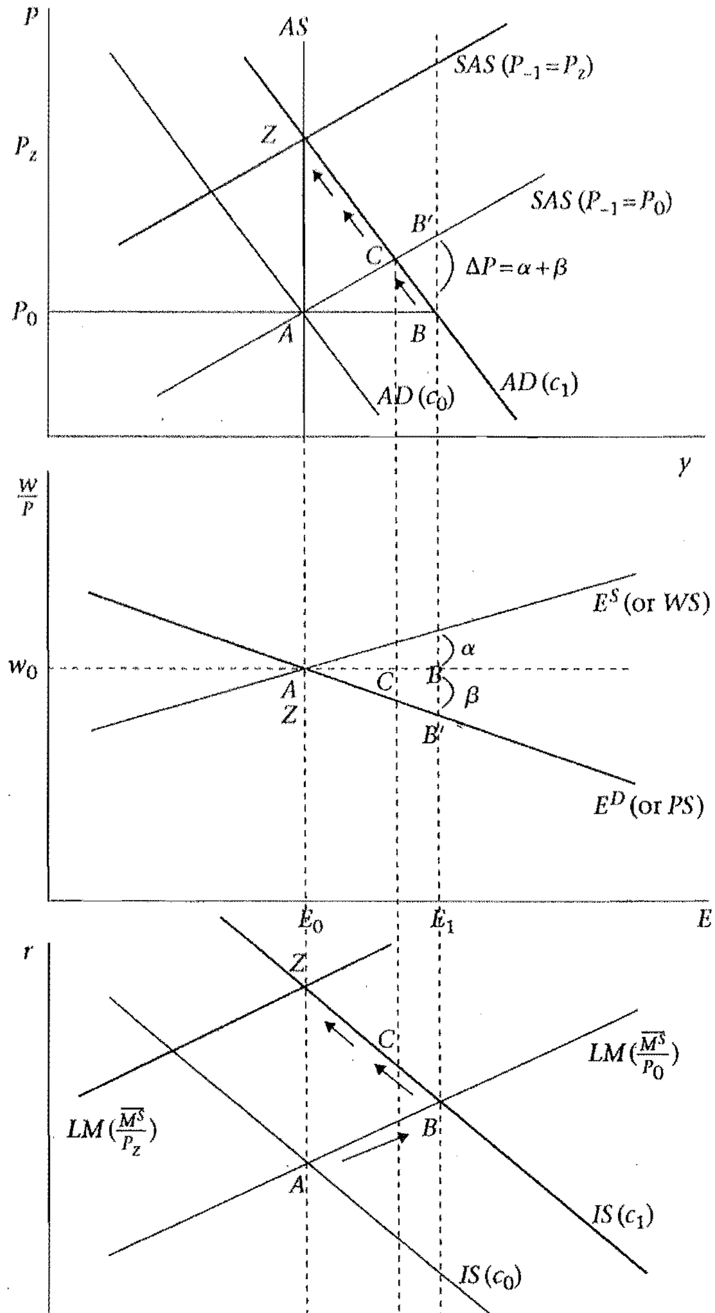

Figure 2.14 The *AD* and *AS* curves

supply more labour, i.e. to move up the labour supply curve. *B* is therefore also a position of labour market equilibrium. A negative supply shock, e.g. a sudden scarcity of a key raw material, would take the economy into a recession as the *MPL* curve shifted to the left leading to a new equilibrium at point *C*. At *C*, workers choose to supply less labour. The fall in employment is entirely voluntary in the sense that given the new circumstances

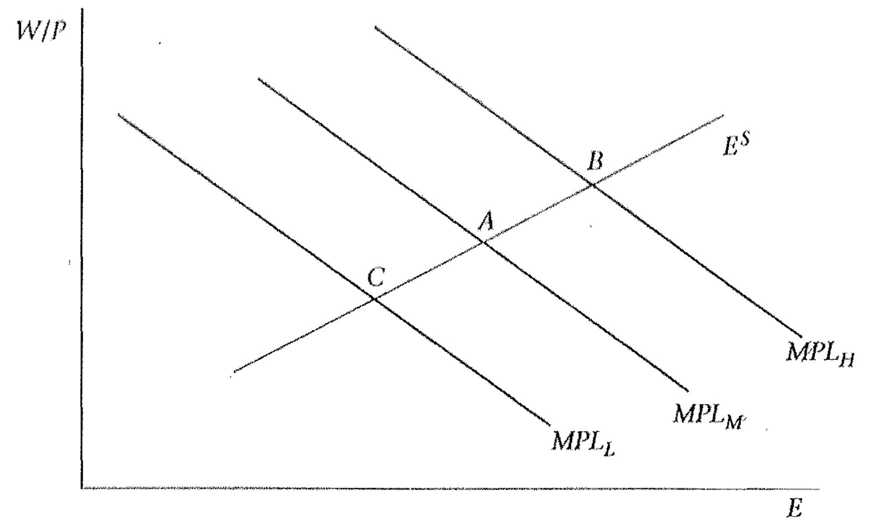

Figure 2.15 The Real Business Cycle model: equilibrium fluctuations due to technology shocks

facing them following the leftward shift in the marginal product of labour curve, workers choose to supply less labour. Workers choose to shift the timing of their supply of labour in response to the shifts in demand by working more in good times and less in bad times. This is called the 'intertemporal substitution of labour'.

Many economists remain sceptical about the idea that

- supply-side forces are the dominant source of business cycle fluctuations and that
- business cycles are purely 'equilibrium' phenomena.

As we shall see in Chapters 13 and 14, technological change plays the key role in explanations of the long-run growth of living standards. However, it seems less plausible that fluctuations in the rate of technical progress lie behind the pattern of booms and recessions that characterize economies. When an economy recovers from a recession, productivity typically rises relative to its long-run trend, with the reverse characterizing a recession. However, this does not mean that it is technical change that is causing the boom and recession—a simpler explanation consistent with the aggregate demand-based view of business cycles is that when aggregate demand falls, firms hold on to workers in the hope that the recession will be short-lived. It is costly to hire and fire workers so labour hoarding is to be expected. This will produce the outcome that productivity falls in recessions (employment is reduced by less than output falls) and rises in booms.

From Fig. 2.15, it is clear that for the RBC mechanism to be able to explain the substantial changes in employment that take place over the business cycle, a small change in the real wage must lead to a large change in the supply of labour, i.e. the labour supply curve needs to be very elastic. However, this does not fit the empirical evidence, which shows that for the main earner in the household, the intertemporal elasticity of labour supply is quite low.[10] Although the RBC approach is not the mainstream view of

[10] Recent evidence is presented in Ham and Reilly (2002) and in French (2004).

what drives business cycles it has had a major influence on the methodology of modern macroeconomics at the research frontier. This is discussed in more detail in Chapter 15.

7.3.2 Business cycles: aggregate demand shocks plus sticky wages and prices

At the opposite extreme from a world of rapidly adjusting wages and prices is the *IS/LM* model, where we assume that wages and prices do not adjust at all in the short run. Returning to Fig. 2.14, the sluggish adjustment of nominal wages and of prices implies the economy does not move directly from A to Z in response to an aggregate demand shock. In Fig. 2.14, the short-run adjustment due to the rightward shift of the *IS* curve is shown in the bottom panel and in the *AD-AS* diagram as the movement from A to B with the price level unchanged at P_0 in the top panel. It is clear from the middle panel that the labour market is not in equilibrium when employment is at E_1.

The short run comes to an end as wages and prices begin to adjust in response to the disequilibrium in the labour market. The nature of the disequilibrium is clear: the prevailing real wage, w_0, is on neither the labour supply nor labour demand curve in the competitive interpretation of Fig. 2.14; nor is it on the *WS* or the *PS* curve in the imperfectly competitive interpretation. The real wage is too *low* to elicit a supply of labour E_1 and too *high* for the employment of E_1 workers to be profitable. Under imperfect competition, wage setters will not be satisfied with a real wage of w_0 if employment is as high as E_1; and if the higher employment is accompanied by falling marginal productivity, then the profit margin cannot be maintained if the real wage remains at w_0. (If the *PS* curve was flat, price-setters would still be in equilibrium at B but wage setters would not.)

One way of explaining what happens once wages and prices begin to adjust is to assume that money wages go up by α—we assume this is interpreted as a real wage increase based on their view of the prevailing price level. But subsequently, prices rise by $\alpha + \beta$ to restore equilibrium on the price-setting side of the labour market. This leaves the economy at point B' in the labour market and *AD-AS* diagrams.[11]

The line through A and B' in the *AD-AS* diagram defines a short-run aggregate supply curve, the $SAS(P_{-1} = P_0)$. The *SAS* curve is indexed by last period's price level, P_{-1} to capture the assumption that when the money wage rises, the implications for the real wage are interpreted by workers in terms of the pre-existing price level, P_0. The slope of the *SAS* depends on the size of α and β and hence on the slope of the labour supply and labour demand curves (or the *WS* and *PS* curves). A flat *PS* curve produces a flatter *SAS* (since $\beta = 0$).

In fact, the economy moves from point B to C rather than to B' because of the impact of the higher price level on aggregate demand. A rise in the price level leads to a fall in the real money supply and the interest rate rises, reducing aggregate demand (the *LM* shifts left; the economy moves north-west up the *AD* curve). When the economy is at point C, the disequilibrium in the labour market is smaller than before but has not completely disappeared. The adjustment from C to Z occurs through the upward shifting of the

[11] We make the simplifying assumption that money wages change first and that prices change immediately afterwards. This implies that the real wage is on the labour demand (or *PS*) curve. By introducing different lags in wage and price adjustment, the real wage during the adjustment from B to Z can be anywhere between the labour demand curve and the labour supply curve or the *PS* and *WS* at the prevailing level of employment. Differences in lag patterns affect the real wage/ employment outcomes as the economy adjusts from B to Z.

SAS curves as the higher price level is incorporated into the next period's labour market decisions. Eventually, the price level rises to P_Z and the $SAS(P_{-1} = P_Z)$ crosses the *AS* curve at *Z*. At *Z*, equilibrium is restored in the labour market.

To summarize, when the *IS/LM* model is combined with sluggish adjustment on the supply side, the results of a positive *IS* shock are as follows:

- the *IS* curve shifts to the right and output and employment rise with the price and wage level unchanged in the short run. This is a business cycle boom. (To analyse a recession, work through the case of a negative *IS* shock.)
- in the labour market, there is disequilibrium and eventually wages and prices move in response.
- the higher price level leads in turn to a reduction in aggregate demand via the 'Keynes effect'.
- workers update the price level on the basis of which they behave, which shifts the *SAS* upwards.
- in the long run, equilibrium is restored with unemployment at the *ERU*, a higher real interest rate (and a change in the composition of output from investment to, in this example, consumption), and a higher price level.

As a final example it is interesting to consider two policy experiments—a change in the nominal money supply, $\overline{M^s}$ and a fiscal expansion. A monetary expansion shifts the *LM* curve and the *AD* curve to the right. The new medium-run equilibrium is at the *ERU*, real wages are unchanged, and the price level and nominal wage level are higher. In the *IS/LM* diagram, the new and old equilibria coincide: the impact of the increase on the money supply on the *LM* curve is reversed by the subsequent rise in the price level. By contrast, after a fiscal expansion, output returns in the medium run to its initial level, but its composition is different as the higher government spending crowds out some interest-sensitive private expenditure.

8 Conclusions

In this chapter, we have come quite a long way in setting out a macroeconomic model for short- and medium-run analysis. We can summarize the findings of the chapter as follows:

- In the short run, the level of employment and output is determined by the level of aggregate demand, which is analysed using the *IS/LM* model. This means that business cycles, i.e. booms and recessions, are due to fluctuations in the level of aggregate demand. Such fluctuations affect employment and output because of the nominal rigidities in the economy, i.e. the stickiness of wages and prices.
- Equilibrium in the labour market occurs where the labour supply and labour demand curves cross in a competitive economy and where the price-setting and wage setting curves cross in an imperfectly competitive economy. At the competitive equilibrium,

any unemployment is voluntary, whereas at the imperfectly competitive equilibrium, there is a mixture of voluntary and involuntary unemployment.

- The wage-setting curve lies above the labour supply curve and it will be further above it the greater are the imperfections in the labour market. Similarly, the price-setting curve lies below the marginal product of labour curve and it will be further below the greater are the product market imperfections. With labour and/or product market imperfections, the equilibrium unemployment rate is higher than the competitive one. Structural and institutional features of the labour and product markets including government regulation affect the slope and position of the *WS* and *PS* curves.

- The aggregate demand and aggregate supply sides of the model are brought together in the *AD-AS* model. Under normal circumstances, the *AD* curve is downward sloping because a lower price level leads to the rebalancing of portfolios and a fall in the interest rate, which stimulates demand. The *AD* curve is vertical if there is a liquidity trap.

- There is a vertical aggregate supply curve at the level of output associated with labour market equilibrium. If prices and wages adjust immediately to any aggregate demand shock, the economy moves vertically up or down the *AS* curve and unemployment remains at the *ERU*. However, we normally assume there is no adjustment of wages and prices in the short run. When adjustment does take place, the economy moves along the *SAS* curve, which shows how wages adjust given the pre-existing price level; prices are assumed to adjust immediately after wages. The *SAS* shifts upwards and the economy eventually reaches the medium-run equilibrium.

- When the economy is in labour market equilibrium (at the *ERU*), the price level is the outcome of the factors that determine aggregate demand and aggregate supply: a shift on either side implies a new price level at labour market equilibrium. A change in the money supply leads to a new medium-run equilibrium characterized by a pure change in the price level with no change in either the level or composition of output.

- The economy fluctuates around the *ERU* as a result of shifts in aggregate demand (i.e. due to factors incorporated in the *IS* or *LM* curves). Business cycles are therefore disequilibrium phenomena. In the perfectly competitive economy, all unemployment when the economy is at the supply-side equilibrium is voluntary; involuntary unemployment arises in the short run when a fall in aggregate demand leads to a reduction in employment below equilibrium, i.e. while prices and wages are fixed. In the imperfect competition model, there is a mixture of voluntary and involuntary unemployment at the *ERU* and there is a rise in involuntary unemployment when a fall in aggregate demand pushes output and employment below the equilibrium.

- A completely different interpretation of business cycles is provided by the Real Business Cycle model. According to the RBC approach, fluctuations on the supply side lie behind cycles. Shifts in the *MPL* curve due to technology shocks generate cycles. These cycles are equilibrium phenomena since the economy is always in labour market equilibrium, irrespective of whether employment is buoyant or depressed. There is no involuntary unemployment.

To take the analysis of business cycles closer to that of contemporary economies, we need to incorporate inflation and an inflation-targeting central bank into the model. This is done in Chapter 3.

QUESTIONS

Checklist questions

(1) What is the *IS* curve? Why does it slope downward? Why does an increase in government spending shift it to the right? What happens to the *IS* curve when the marginal propensity to consume rises? [Explain using words and either diagrams or equations; see the Appendix for the equations.]

(2) Assume that the interest rate is constant. Explain in words what happens when there is an increase in government spending. In so doing, explain the concept of the multiplier.

(3) What is the *LM* curve and why does it slope upward? What happens to the *LM* curve when (*a*) there is an increase in the demand for money (at a given level of income and interest rate); (*b*) the interest elasticity of the demand for money rises?

(4) Briefly explain why it is the real interest rate that is relevant for the *IS* curve and the nominal interest rate for the *LM* curve.

(5) Provide two different explanations for why the *PS* curve may be flat.

(6) Why is the *WS* curve upward sloping (*a*) when wages are set by unions and (*b*) when wages are set by firms?

(7) 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?

(8) Discuss the plausibility of the assumptions in the previous question. Discuss the implications of the timing assumptions for the way real wages move in response to fluctuations in aggregate demand.

(9) What are the similarities and differences between the characteristics of labour market equilibrium under perfect as compared with imperfect competition?

(10) Show the likely effects on price- and/or wage setting behaviour as reflected in the *WS*/*PS* diagram of the following:
  (*a*) workers become more worried about losing their jobs at any given level of employment
  (*b*) the government intervenes to protect domestic firms from foreign competition
  (*c*) higher social security contributions paid by employers

(*d*) a reduction in the proportion of employees covered by union wage agreements (e.g. as the result of a decline in industries in the economy that are heavily unionized).

(11) In the context of tripartite negotiations between unions, employers' associations, and the government, union bosses strike a deal whereby they agree to make lower wage demands. Show the effect in the *WS/PS* diagram if they do so in return for:

(*a*) a reduction in the length of the working week so that workers finish at lunchtime on Fridays (assume that wages and productivity on the vertical axis are measured per week)

(*b*) statutory improvements in working conditions that boost morale.

(12) Does the aggregate demand curve for the whole economy slope down for the same reason as does the demand curve for DVDs?

(13) Explain why the long-run aggregate supply curve is vertical but the short-run one is not.

Problems and questions for discussion

QUESTION A. In an *IS/LM* model of the economy, why does the slope of the *IS* curve matter for macroecononomic policy analysis? Choose a policy instrument that will change the slope of the *IS* and explain why. What can you conclude from this example about how fiscal and monetary policy may interact?

QUESTION B. Suppose that there is a large temporary fall in private sector investment. What would you expect the effect of this to be? What would you expect to determine how long the effect lasts?

QUESTION C. Use the *IS/LM* model and compare the short-run implications of the use of two different monetary policies. Policy 1 is to keep the interest rate constant and Policy 2 is to keep the money supply constant. Choose a private sector '*IS*' shock that depresses the level of equilibrium output. Compare the implications for output of the use of Policies 1 and 2. Now choose a private sector '*LM*' shock that lowers equilibrium output and complete the same exercise as above. If the authorities are interested in stabilizing the economy, would you recommend that they adopt Policy 1 or Policy 2?

QUESTION D. Real wages are mildly procyclical in most industrial economies. Explore which models of wage and price formation and which sources of fluctuations in economic activity are consistent with this observation.

QUESTION E. Keynes emphasizes the weakness of the self-equilibrating forces in a capitalist economy and highlights the role of government in stabilization. Milton Friedman argues that Keynes's influence on public policy was enormous:

> Keynes believed that economists (and others) could best contribute to the improvement of society by investigating how to manipulate the levers actually or potentially under control of the political authorities so as to achieve desirable ends, and then persuading benevolent civil servants and elected officials to follow their advice. The role of voters is to elect persons with the right moral values to office and then let them run the country.[12]

[12] Friedman (1997).

Think about Friedman's argument and consider what it suggests is the proper role for economists in policy making. Do you agree with him?

APPENDIX: SIMPLE MATHS OF *IS/LM*

The *IS* curve

Assume that the consumption, investment, and tax functions are linear:

$$c = c_0 + c_y(y - t),$$

where c_0 is autonomous consumption and c_y is the constant proportion of current disposable income that is consumed: $0 < c_y < 1$;

$$t = t_y y, \qquad \text{(tax function)}$$

where $0 < t_y < 1$. Thus if we substitute the tax function into the consumption function and rearrange the terms, the consumption function is:

$$c = c_0 + c_y(1 - t_y)y. \qquad \text{(consumption function)}$$

The investment function is

$$I = A - ar, \qquad \text{(investment function)}$$

where a is a constant. In goods market equilibrium,

$$\begin{aligned} y &= y^D \\ &= c_0 + c_y(1 - t_y)y + A - ar + g. \end{aligned}$$

Solving for y gives:

$$y = \frac{c_0 + A + g}{s_y + c_y t_y} - \frac{a}{s_y + c_y t_y} \cdot r. \qquad \text{(}IS\text{ curve)}$$

Construct the *IS* curve in $r - y$ space by first setting $r = 0$ to get the intercept of the *IS* curve on the y-axis (Fig. 2.16); when $r = 0$,

$$y = \frac{c_0 + A + g}{s_y + c_y t_y};$$

similarly for the intercept of the *IS* curve on the r-axis; when $y = 0$,

$$r = \frac{c_0 + A + g}{a}.$$

(1) Change in the size of the multiplier: An increase in the multiplier has no effect on $\frac{c_0+A+g}{a}$ with the result that the r-intercept is unaffected. A rise in the multiplier simply shifts $\frac{c_0+A+g}{s_y+c_y t_y}$ to the right along the horizontal axis. The *IS* rotates counter-clockwise, as shown in Fig. 2.16.

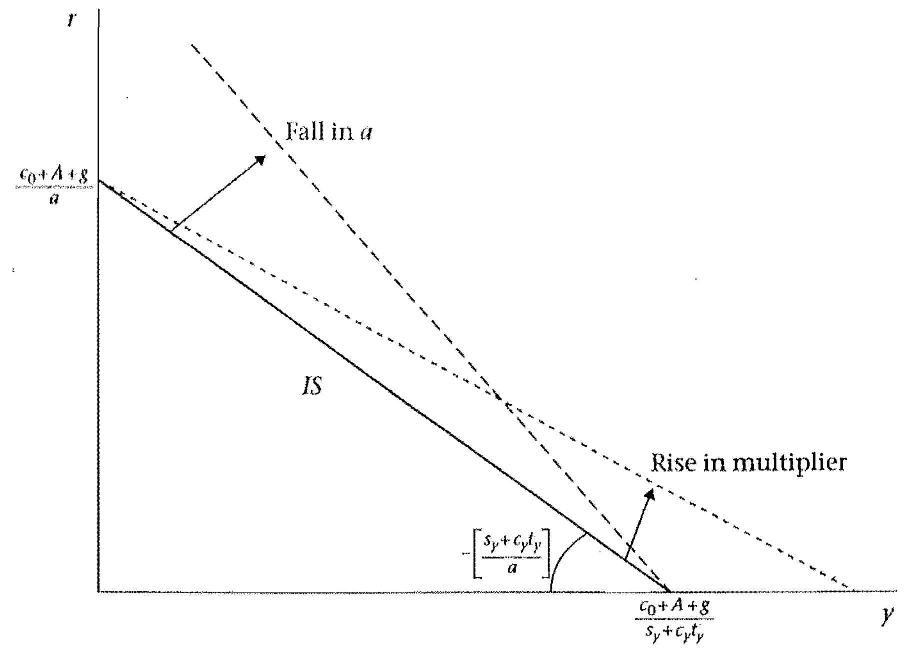

Figure 2.16 The *IS* curve

(2) Change in the interest-sensitivity of investment: A reduction in the interest-sensitivity of investment has no effect on the y-intercept; it simply shifts $\frac{c_0+A+g}{a}$ up the vertical axis. The *IS* curve rotates clockwise, as shown in Fig. 2.16.

(3) Change in the components of autonomous spending: An increase in c_0, A, or g produces a parallel outward shift of the *IS* curve since its slope is unchanged.

The *LM* curve

Assume that the demand for money function is linear and write it in real terms:

$$\frac{\overline{M^S}}{P} = \bar{l} - l_i i + \frac{1}{v_T} \cdot y.$$

Solving for i gives,

$$i = \frac{\bar{l} - \frac{\overline{M^S}}{P}}{l_i} + \frac{1}{v_T l_i} y. \qquad (LM \text{ curve})$$

Construct the *LM* curve in $i - y$ space by first setting $i = 0$ to get the intercept of the *LM* curve on the y-axis (Fig. 2.17); when $i = 0$,

$$y = v_T \left(\frac{\overline{M^S}}{P} - \bar{l} \right);$$

similarly for the intercept of the *LM* curve on the i-axis; when $y = 0$,

$$i = \frac{\bar{l} - \frac{\overline{M^S}}{P}}{l_i}$$

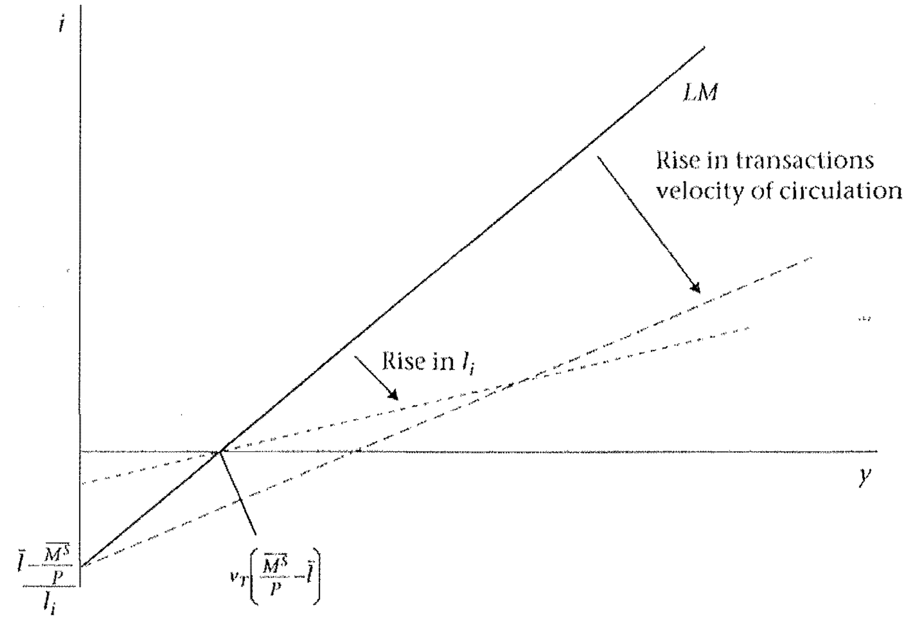

Figure 2.17 The *LM* curve

(1) Change in the transactions velocity of circulation: A rise in the transactions velocity of circulation v_T as the result for example of financial innovation means that the intercept of the *LM* with the vertical axis is unchanged while the intersection with the horizontal axis moves to the right. Thus the *LM* rotates clockwise, becoming flatter, as shown in Fig. 2.17.

(2) Change in the interest sensitivity of the demand for money: A rise in l_i, the interest-sensitivity of the demand for money, has no effect on the intercept of the *LM* with the y-axis. It shifts the intercept with the vertical axis upward. Thus the *LM* rotates in a clockwise direction about the horizontal intercept, becoming flatter (Fig. 2.17).

(3) Change in the money supply: A rise in the money supply shifts the *LM* rightwards with no change in the slope. The size of the shift will be $v_T(\Delta M^S/P)$.

(4) Change in the price level. A rise in the price level shifts the *LM* leftwards with no change in the slope. The size of the shift will be $v_T(M^S/\Delta P)$.