Explain why it matters and how this distinction might be made.

3 Why do central banks need to have targets? Discuss and evaluate the various possible targets.

4 Having purchased vast amounts of public debts, the ECB is worried of suffering large losses in case some governments default. There is a risk that its net worth (see Figure 9.4) could become negative. Yet, some highly reputed central banks, like the Banco Central de Chile and the Bank of Israel—have operated for years with a negative net worth. Is this a problem? Discuss.

5 In April 2007, the Governor of the Bank of England had to write his first letter to the Chancellor of the Exchequer to explain why it missed the inflation target. Read the letter <www.bankofengland.co.uk/monetarypolicy/pdf/cpiletter070417.pdf> and the Chancellor's response <www.hm-treasury.gov.uk/media/7/4/chxresponse_170407.pdf>. What are the Governor's explanations and what do you think of the Chancellor's response?

Macroeconomic Equilibrium in the Short Run

10

The long run is a misleading guide to current affairs. In the long run we are all dead.

J. M. Keynes

10.1 Overview

John Maynard Keynes said a lot in his short life, but this description of the long run is perhaps his best-known pronouncement. On the one hand, it is a normative and controversial judgement that policies should care more about the present than the distant future. But it is also a statement of fact: the economy needs time to reach that long run, and we need to understand what happens in the meantime. This chapter is concerned with the central question of macroeconomics posed in Chapter 1: Why do countries experience business cycles? These recurrent, irregular periods of ups and downs are presented in a stylized way in Figure 10.1. We saw in Chapters 3 and 4 that, in the long run, the GDP appears to increase without limit. This long-run growth is shown by the smoother curve displaying an upward trend. In the short run, however, economic activity fluctuates around that trend, with periods of relatively fast growth followed by periods of slowdown, or even negative growth called **recessions**. This chapter shows that business cycles can be explained by disturbances, or shocks, that originate in goods and financial markets.

Fig. 10.1 Cyclical Fluctuations

The Keynesian assumption helps explain short-run fluctuations of real GDP around its long-run growth trend.

To study the short run behaviour of the economy, we adopt a crucial **Keynesian assumption** that prices are constant. In most countries where inflation is low, it is a reasonable assumption over, say, a couple of years. This is why this chapter is about the short run. The Keynesian assumption is a convenient analytical short cut. Not having to track prices will simplify the analysis a lot. It turns out that it is also a rather accurate description of the short run.

Macroeconomic price flexibility is a reasonable working assumption for the long run. Under price flexibility, the monetary neutrality principle applies, and money and prices behave independently of output. This long-run independence, or **dichotomy**, of the real and monetary dimensions of the economy was stressed in Chapter 6 and serves as an important anchor for analysis. But by adopting the Keynesian assumption, we will upset this dichotomy. Under the condition that prices are constant, rigid or just 'sticky' (i.e. slow-moving), it implies that the nominal and real sides of the economy interact with each other. Macroeconomics therefore incorporates two fundamentally different perspectives. In the long run, prices are fully flexible and neatly separate out nominal and real sides of the economy. In the short run, prices do not move, or move rather slowly, the dichotomy fails and everything becomes more complicated. The working assumption of constant prices will help us explain more easily the complex aspects of the business cycle.

The Keynesian model focuses on two markets: (1) the market for goods and services—which we will henceforth call the goods market, and (2) the money market, which we studied in Chapter 9. In the next chapter we will add the foreign exchange market, providing an open economy version of the Keynesian model. Our reasoning follows the **general equilibrium** approach. General equilibrium is the simple requirement that all markets achieve equilibrium *at the same time*, and that these equilibrium conditions are mutually consistent with each other. This is a very powerful method of analysis, which allows us to capture the many interactions that take place among the different markets in one step. Figure 10.2 offers a preview of the full open economy analysis. Through the interest rate, the money market affects the goods market, and thus the level of output. The goods market, in turn, affects the demand for money and thereby the interest rate. Later on, we will also allow the real exchange rate to influence the demand for domestic goods. We will see how interest and exchange rates affect each other, and therefore the goods market.

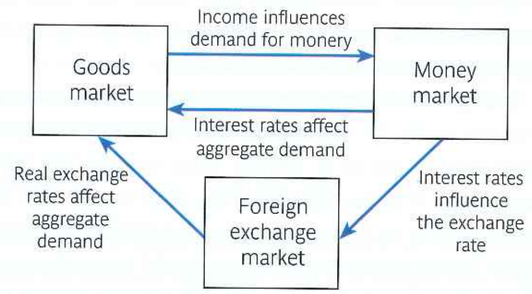

Fig. 10.2 General Macroeconomic Equilibrium

Conditions in domestic money and goods markets affect each other. Interest rates and exchange rates influence the level of aggregate demand, while income affects the demand for money and, for a given money supply, interest rates. General equilibrium occurs when equilibrium conditions in the three markets are consistent with each other.

10.2 Aggregate Demand and the Goods Market

10.2.1 The Market Equilibrium Assumption

We start with the fundamental accounting identity of Chapter 2:

$$Y = C + I + G + \text{PCA}, \tag{10.1}$$

where all variables are measured in real terms, i.e. at constant prices. In Chapter 2, we presented this equation as an identity which described the various categories of spending on domestic goods that make up the GDP. As a definition, this equation is true by construction and we could leave it at that, but here we view it in a different light. We now think of the left-hand side of (10.1) as the **supply** of goods and services by domestic producers, while the right-hand side brings together various components of world **demand** for goods and services produced domestically. These components are given by C, the demand by resident households for consumption goods, investment spending I by firms on capital goods, the public sector's own demand for goods G, and the primary account PCA. The PCA is the difference between the world's demand for our goods, exports X, and the domestic demand for foreign goods, imports Z.

Viewed this way, (10.1) is no longer a definition or an identity. Rather, it is a market equilibrium condition. We require it to hold not only because national accountants get numbers right, but because we *assume* that the goods market is in equilibrium so that demand equals supply. But how are the two brought into balance?

When we look at particular markets (apples, clothing, computers, machines tools, steel, oil, etc.), we usually think of that good's price as the mechanism which brings demand and supply in line. When looking at the macroeconomic picture, all goods and services that enter GDP, and the average price of these goods is the price level. In the short run, it is convenient and realistic to adopt the Keynesian assumption that prices on average are sticky, i.e. that they move slowly and in a predetermined way. In the language of macroeconomics, the price level is assumed to be exogenous. Later on, in Chapters 12 and 13, we will return to that assumption and allow the general price level to respond endogenously to evolving aggregate demand and supply forces.

To see what a fundamental difference this assumption can make, let us suppose that demand (the right-hand side of (10.1)) is greater than supply (the left-hand side). If prices were flexible, they would rise, as prices tend to do when there is excess demand. Higher prices would lower demand, but would also raise supply. If they are sticky, how can the market return to equilibrium? The Keynesian answer implies that we can now interpret (10.1) as an *explanation* of GDP's movements over time. Demand responds to exogenous forces, while supply responds passively to shifts in demand. For the short run, this is the central and far-reaching implication of the Keynesian assumption.

10.2.2 Determinants of Demand

What, then, are those exogenous forces that shape demand? In order to answer this question, we need to think hard about the behaviour of consumers, firms, and the primary current account (PCA). In doing so, we will return to many of the insights from Chapters 7 and 8: the behaviour and resource constraints of households, enterprises and the government. As a short cut, we consider public spending G and tax receipts T as exogenous; in words, the behaviour of the public sector is independent of economic conditions. To emphasize this assumption, we will frequently write exogenous variables with an upper bar: $\bar{G}$ and $\bar{T}$.

In Chapter 8 we explained the factors which drive private consumption and investment in detail. Now, all we need to do is to synthesize these results in a simple and compact way. We start with consumption, which originates in household behaviour. Measured in real terms, consumption is driven by wealth and disposable income. Wealth, represented by the symbol Ω, is assumed to be exogenous.[1] Disposable income Y^d, income after tax, is the difference between GDP Y and tax payments by the private sector $\bar{T}$, which is measured net of transfers to households and firms. Our description is summarized by the following **consumption function**:

$$\textbf{(10.2)} \qquad C = C(\underset{+}{\Omega}, \underset{+}{Y-\bar{T}}). \qquad \text{(consumption function)}$$

As before, signs underneath the two determinants of consumption indicate the effect of each variable on demand. More wealth and a higher disposable income each raise consumption demand. Note that, while taxes are assumed to be exogenous at this stage, GDP is endogenous, and represents total aggregate income, which is equal to total demand, which we are in the process of explaining.

In Chapter 8 we also studied the demand by firms for investment goods. Although it is a smaller fraction of total demand, it tends to fluctuate the most and is considered by most macroeconomists to be highly relevant for the ups and downs of the business cycle. This demand is represented by the following form of the **investment function**:

$$\textbf{(10.3)} \qquad I = I(\underset{+}{q}, \underset{-}{r}). \qquad \text{(investment function)}$$

The investment function states that investment expenditures increase when Tobin's q increases, and decline when the interest r rises. Remember from Chapter 8 that, all other things equal, investment is driven by business expectations or entrepreneurial 'animal spirits'. This is captured by Tobin's q. The interest rate matters for investment for two reasons: (1) because a higher interest rate reduces Tobin's q; (2) because firms borrow from banks to finance investment.[2] When borrowing costs rise, firms invest less.

The interest rate is an important variable in the analysis of this chapter, so it will be useful to make clear which interest rate we are talking about. In Chapters 7 and 8 we studied the *real* interest rate r, which measures the real cost of borrowing or the return to lending. Later, in Chapter 9, we examined the *nominal* interest rate, denoted by i, which is quoted by banks or reported in the financial press. We learned that the nominal interest rate is the cost of holding money, and that includes a component which reflects inflation. Later, when we study inflation in Chapter 13 and afterwards, we will distinguish between the nominal and real interest rate. The Keynesian assumption that prices are sticky implies that inflation is zero or negligible, so we can treat these two rates as the same. For future reference, however, we note that it is the real interest rate r that matters for spending decisions and the nominal interest rate i that is relevant when we look at monetary questions.

Then there is the last term in (10.1), the primary current account (PCA). Recall that the primary current account surplus is defined in Chapter 2 as the difference between exports (X) and imports (Z) of goods and services, measured in terms of domestic output:

$$\textbf{(10.4)} \qquad PCA = X - Z.$$

First consider imports. Recall that total domestic spending, also called absorption (A), includes spending on both domestically produced and imported goods and services.[3] Imports are thus a component of absorption: the more we spend, the more we import. This proportion need not be constant, however. In particular, it will depend on the country's competitiveness. In Chapter 6, we saw that competitiveness can be measured by the real exchange rate σ, the relative price of domestic to foreign goods. A real depreciation—a decrease in σ—makes foreign goods relatively more expensive, and therefore discourages imports. Conversely, a real appreciation—an increase in σ—boosts imports, which are now cheaper. These observations are summarized by the **import function**, which says that imports rise with absorption and with the real exchange rate:

$$\textbf{(10.5)} \qquad Z = Z(\underset{+}{A}, \underset{+}{\sigma}).$$

Turning to exports, we need only recognize that they are the imports of the rest of the world. Accordingly, they behave as our imports, from the foreign perspective. Thus our exports depend on foreign absorption A^* (and its determinants, foreign wealth Ω^*, foreign disposable income Y^{d*}, foreign Tobin's q^*, etc.). If our real exchange depreciates—if σ decreases—our goods become cheaper in the foreigners' eyes and stimulate our exports. Conversely, a real appreciation—an increase in σ—depresses exports, which have become more costly. We bring these observations together in the form of the **export function**:

$$\textbf{(10.6)} \qquad X = X(\underset{+}{A^*}, \underset{-}{\sigma}).$$

We combine these results in the form of the **primary current account function**, which is simply the difference between the export and import functions in (10.5) and (10.6):

$$\textbf{(10.7)} \qquad PCA = X(\underset{+}{A^*}, \underset{-}{\sigma}) - Z(\underset{+}{A}, \underset{+}{\sigma}) = PCA(\underset{-}{A}, \underset{+}{A^*}, \underset{-}{\sigma}).$$

The PCA function tells us that any factor that boosts one of the components of domestic absorption $A = C + I + G$ (increases in wealth, disposable income, Tobin's q, real growth, public spending or tax cuts, or a decline in the interest rate) will increase imports and reduce the primary current account (increase the primary account deficit). In contrast, anything that boosts foreign spending (increases in foreign wealth, disposable income, Tobin's q, real growth, public spending and tax cuts, or a decline in the foreign interest rate) will increase foreign absorption A^* and therefore our exports, which improves our primary current account. Finally, a real exchange rate appreciation (an increase in σ) leads to a deterioration of the primary account as imports rise and exports fall. Conversely, a real depreciation improves the primary account.

Macroeconomists like to take short-cuts. Because the factors that affect absorption and aggregate demand also affect output—that is the Keynesian assumption—then factors that affect absorption will ultimately affect output. The obvious short-cut is to replace the PCA function in (10.7) with the following version:[4]

$$\textbf{(10.8)} \qquad PCA = PCA(\underset{-}{Y}, \underset{+}{Y^*}, \underset{-}{\sigma}). \qquad \text{(primary current account function)}$$

[1] Generally, wealth changes very slowly in response to household savings, so this assumption can be justified for short-run analysis. On the other hand, when asset prices change, wealth can change suddenly. An good example of this is consequence of the recent collapse of housing prices in the United States, Spain, and Ireland. We return to this point later on.

[2] More precisely, firms use the interest rate to evaluate investment projects. This explains not only why Tobin's q falls when interest rates rise, but it also explains why a firm deciding how to invest its money would invest less in physical equipment when interest rates are higher.

[3] Recall that absorption A is defined as $A = C + I + G$.

[4] This is done to avoid carrying along one more variable, absorption. We could keep absorption in our formulation and, in the end, eliminate it. We would just end up where we will soon be. Exercise 11 at the end of this chapter invites you to check this assertion.

In the end, we will work with this primary current account function, which states that the PCA is negatively related to domestic real income, positively to foreign income, and negatively to the real exchange rate. This completes the picture of aggregate demand in an open economy.

10.2.3 Goods Market Equilibrium

The groundwork having been laid, we can proceed to study equilibrium in the goods market. We know how much consumers want to buy, how much firms want to invest in productive equipment, and the government's spending intentions. In addition, we have characterized how much of all that should fall on domestic or foreign goods and the intentions of foreign customers. Adding up the various demand functions according to the national income identity, we obtain the planned or **desired demand function**:

$$DD = C(\underset{+}{\Omega}, \underset{+}{Y-\bar{T}}) + I(\underset{-}{r}, \underset{+}{q}) + G + PCA(\underset{-}{Y}, \underset{+}{Y^*}, \underset{-}{\sigma}). \quad \textbf{(10.9)}$$

(desired demand function)

Why is this called 'desired' and not actual demand? In short, because a number of the factors that drive aggregate demand—real GDP, the real interest rate, Tobin's q, the real exchange rate—also depend on demand, as we shall see. For instance, real income Y affects demand, but at the same time it represents aggregate supply which, according to the Keynesian assumption, adjusts to demand. So (10.9) describes what aggregate demand would be—what the economy would desire to spend—given particular values of these endogenous variables, not necessarily what it will in fact be. Indeed, we need to ascertain that the values of these endogenous variables are compatible with each other.

While this may seem like a bad case of circular reasoning, it illustrates the fundamentally simultaneous nature of general equilibrium in economics. It simply corresponds to the circular flow diagram presented in Chapter 2. This diagram shows that what is spent must be earned so that the GDP measures both total income and total output. The point of the desired demand DD function is to cut through the circularity. It tells us what demand should be *given* GDP, which is total income. At the same time, GDP also measures output, which is determined by demand under the Keynesian assumption. A graphical analysis will help us understand this simultaneous determination of demand and output.

We start with a description of how Y (GDP) affects desired demand, ignoring for the time being the other variables shown on the right-hand side of (10.9). We note that Y matters in two ways: first, it affects consumption positively. But, second, it also exerts a negative effect on the primary account, since higher income increases imports. Which effect dominates? Theory and evidence say that it is the consumption effect. The reason is that imports represent a fraction of domestic spending. When an increase in GDP causes consumption to rise, imports too rise but by a (variable, the real exchange rate matters as well) fraction of consumption. In the end, desired demand (also called aggregate demand) rises with the GDP, which is represented in Figure 10.3 by the upward-sloping DD

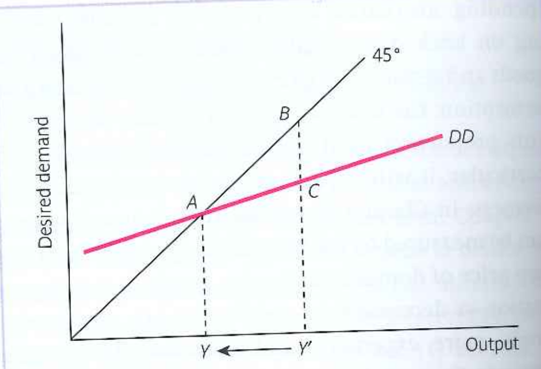

Fig. 10.3 The 45° Diagram

Desired demand DD increases with income (which derives from the sale of output), but less than proportionately, because part of any additional income is typically saved and part of spending falls on imported goods. Equilibrium occurs when demand equals supply, i.e. when firms produce output—measured along the horizontal axis—equal to desired demand—measured along the vertical axis. This happens along the 45° line. Equilibrium occurs at point A, where desired demand and output are equal. The corresponding output level Y is called equilibrium GDP. If output exceeds its equilibrium level, for example Y', supply (point B) exceeds demand (point C) so firms accumulate inventories of unsold goods. Sooner or later, they will cut production and the economy will move towards equilibrium.

schedule (or curve). But demand increases less than the GDP, which explains why the DD schedule is flatter than the 45° line. This is formally shown in Box 10.1.

The goods market is in equilibrium when GDP, interpreted as output, is equal to GDP interpreted as spending. Output, the left-hand side of (10.1), is represented by the horizontal axis in Figure 10.3, while desired spending, the right-hand side of (10.1) and described by (10.9), appears on the vertical axis. Market equilibrium requires that both be equal. Graphically, it means that equilibrium must occur along the 45° line. The DD schedule describes how much people want to spend, given their income, which they can freely choose. Point A, at the intersection of both schedules, represents the situation where desired aggregate demand is met, i.e. is equal to output. This state is called **goods market equilibrium** and the corresponding output level, Y, is **equilibrium GDP**.

To grasp the meaning of equilibrium in the goods market, consider the case where GDP is Y', above its equilibrium level Y. Output is represented vertically by point B, desired demand by point C. The fact that B is above C means that we face a situation of excess supply. Since no one is forced to spend more than they freely choose, firms can only sell the quantity represented by point C. In this situation, firms produce more than their customers want to buy. The excess supply, measured by BC, is stored aside as inventories of unsold goods. This is a situation that cannot last very long because firms will not produce goods that they cannot sell. Sooner or later, they will reduce their production and the output level will decline. Graphically, production moves from point B down and to the left along the 45° line. Less production means less income and desired spending declines. Graphically, desired spending moves from point C down and to the left along the DD schedule. The process will continue until we reach point A. Conversely, starting below equilibrium GDP, we observe a situation of excess demand. Firms satisfy this demand at first by drawing down their previously accumulated inventories but, at some point, they will raise production and the economy will move rightward until point A is reached.

Box 10.1 The Slope of the *DD* Schedule

The slope of the DD schedule is measured by the increase of desired demand in response to an increase in output. From equation (10.9) we see that GDP, which also measures total income, affects desired demand via consumption and via the primary current account:

$$\Delta DD = \Delta C + \Delta PCA.$$

Let's look at each channel separately. From Chapter 8, we know that consumption increases by less than income because consumers wish to smooth changes in income:

$$\Delta C < \Delta Y.$$

A simple way of describing this result is to introduce the marginal propensity to consume c, which captures the response of consumption to a (marginal) change in income: $\Delta C = c\Delta Y$. If $c < 1$, then indeed $\Delta C < \Delta Y$.

Next, consider the PCA, the difference between exports X and imports Z. Exports do not demand on domestic GDP, while imports rise with spending and therefore with GDP. Overall, therefore, the primary account deteriorates when GDP rises:

$$\Delta PCA = -\Delta Z < 0.$$

Suppose, for simplicity, that imports are a constant fraction z of consumption, say $Z = zC$, and that all investment goods are bought from a domestic producer. Thus, we have $\Delta Z = z\Delta C$. The proportion z must be less than one. Since it is positive, it implies that $1 - z$ too is positive but also less than one. Putting this altogether, we have

$$\Delta DD = \Delta C - z\Delta C = (1 - z)\Delta C = (1 - z)c\Delta Y.$$

Since both c and $1 - z$ are both less than one, it follows that $\Delta DD < \Delta Y$, the slope of the DD schedule, $(1 - z)c$, is less than 1, and the DD schedule is flatter than the 45° line.

Let's summarize what we have learned about the goods market in the short run. First, GDP returns to its equilibrium level because firms adjust the production level to meet the market's demand. Second, any disequilibrium in the goods market is relatively short-lived. Firms use their inventories as a buffer. They accumulate inventories when demand is unexpectedly weak and they run down inventories when demand outstrips production. This is why firms carefully monitor their inventory levels.

It may appear that some fundamental accounting identity is violated in this description of an economy out of equilibrium. The national accountants solve that problem by treating the accumulation of inventories as final sales. Implicitly, firms sell to themselves the goods that they stock—they 'invest' in extra inventories. For instance, with output at Y', income and GDP exceed the aggregate demand forthcoming by the amount BC, while total GDP is read off point C. Conversely, inventory decumulation is treated as negative sales and subtracted from actual spending–as if firms would disinvest, or buy back from themselves the goods that they sell from existing stock.[5]

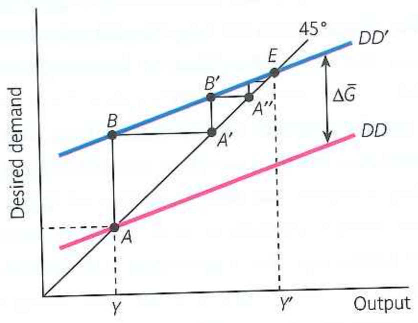

Fig. 10.4 The Multiplier

An exogenous increase in government spending shifts the demand schedule vertically by $\Delta\bar{G}$. Supply rises to meet increased demand, and the economy's equilibrium output ultimately rises to point Y'. The multiplier effect—that the change in output ΔY (given by $Y' - Y$) exceeds the initial impulse $\Delta\bar{G}$—can be understood by following the staircase up from point A. The direct effect, an increase in demand and output, raises GDP to point A'. However, this point is still not equilibrium, because DD lies above the 45° line. Thus, desired demand and output increases again, to point A'', and so on, all the way to point E.

10.2.4 The Keynesian Multiplier

The DD schedule captures the effect of GDP on demand, taking as constant all the variables besides GDP. If these variables change, the DD schedule will shift and equilibrium GDP will change. Understanding these effects provides the first explanation of output fluctuations, the purpose of this and subsequent chapters.

For example, public spending on goods has been considered as exogenous thus far and constant. What would happen if it were to increase by $\Delta\bar{G}$, from $\bar{G}$ to $\bar{G}'$? We look at what happens in Figure 10.4, assuming that the economy starts from equilibrium at point A with real GDP level Y. Desired demand has now increased by $\Delta\bar{G}$, at any level of output. As a result, the desired demand schedule shifts upwards by that amount. With output equal to Y, the new situation is described by point B, where desired demand exceeds output. For a while, producers will make up the difference by drawing down their inventories but, within a few weeks, they will start raising their output to match the new demand. They will continue to do so until equilibrium output is reached at point E and output has risen to Y'.

Let us track down what happens on the way from A to E. At the initial output level Y, desired demand first increases by ΔB. Excess demand $AB = \Delta B$ is eliminated when firms increase production by $BA' = AB$ and the economy moves to point A'. Yet point A' is not a market equilibrium, since it is not on the DD' schedule. At point A' we have neglected to account for the fact that, when output rises from A to A', income does too, raising desired demand to point B'. As firms raise output to eliminate the excess demand AB, more income is generated, which creates more excess demand in the amount $A'B'$. Firms will again raise output by $A'B'$, which takes the economy to A''. And once again, more output means more income and therefore a higher level of desired demand. The staircase

[5] More precisely, national accountants treat the accumulation of inventories as an investment: total investment is the sum of desired investment and undesired inventory accumulation: $Y = C + I^{\text{desired}} + \Delta(\text{inventories}) + \bar{G} + \text{PCA}$.

Box 10.2 The Multiplier's Algebra

In Box 10.1, we showed that the slope of the DD schedule is $c(1-z)$. So when government spending increases by $\Delta\bar{G}$, output and therefore incomes first increase by $\Delta\bar{G}$ as well.[6] This so-called first-round effect is the size of the first step in Figure 10.4. Then desired spending increases by $c(1-z)\,\Delta\bar{G}$, which is the size of the second step. The third step corresponds to an income increase of $c(1-z)\,\Delta\bar{G}$, so desired spending increases by $c(1-z)\,[c(1-z)\,\Delta\bar{G}] = c^2(1-z)^2\,\Delta\bar{G}$. Since c and $1-z$ are smaller than 1, c^2 is smaller than c and $(1-z)^2$ is smaller than $(1-z)$. Continuing in the same way, the size of the next step is $c^3(1-z)^3\Delta\bar{G}$, etc. In the end, the whole income increase is

$$\Delta Y = \Delta\bar{G} + c(1-z)\Delta\bar{G} + c^2(1-z)^2\Delta\bar{G} + c^3(1-z)^3\Delta\bar{G}$$
$$+ \ldots + c^n(1-z)^n\Delta\bar{G} + \ldots$$

$$= [1 + c(1-z) + c^2(1-z)^2 + c^3(1-z)^3 + \ldots$$
$$+ c^n(1-z)^n + \ldots]\Delta\bar{G}$$
$$= \frac{1}{1-c(1-z)}\Delta\bar{G}.$$

The last formula is a standard result from algebra (if a is less than one, $1 + a + a^2 + \ldots + a^n + \ldots = \frac{1}{1-a}$). This shows that the multiplier is $\frac{1}{1-c(1-z)}$, which is larger than unity. Note that, if there is no leakage to savings ($c = 1$) and to imports ($z = 0$), the multiplier would be infinite. Needless to say, this case is not of practical relevance.

process continues until the economy reaches point E, which is on both the new desired demand schedule and the 45° line.

How do we know that this apparently unending process stops at point E? Note that the first step of the staircase is of size $AB = BA' = \Delta\bar{G}$. The second one, of size $A'B' = B'A''$, is smaller. The graphical reason is that the desired demand schedule DD is flatter than the 45° line, and there are two reasons for this. First, some of the additional income created is saved and not spent. Second, some of the extra spending falls on imports, and imports create income abroad, not at home. Thus while more demand creates an equal increase in supply and therefore income, the extra spending generated by the additional income is smaller. Savings and imports operate as leakages which drain some of the newly created income away from additional spending. This is why each step in the staircase is smaller than the previous one. Eventually, the steps become minuscule. Box 10.2 gives a formal description of this process.

The other remarkable result is that ΔY, the total increase of output from Y to Y', is a *multiple* of the initial exogenous increase in demand $\Delta\bar{G} = AB = BA'$. This is why the effect is called the **Keynesian demand multiplier**. It is very general: no matter which exogenous change triggers the process, and whether the disturbance is positive or negative, equilibrium output always responds to demand, sometimes by a larger amount.[7]

The multiplier effect corresponds to the fundamental insight provided by the circular flow diagram in Chapter 2. Each individual's spending is someone else's income. By raising incomes, an exogenous increase in demand generates additional desired demand, which means more spending and income, a never-ending process, although at each stage, the effect becomes smaller, and eventually dies out. The circular flow diagram showed where these leakages occur: taxes, savings, and imports each capture a portion of any additional income.[8] These three leakages

[6] This embodies an important assumption that the entire first round of spending is spent on goods produced domestically. In many open economies this assumption is implausible, so that some of the first round 'leaks' immediately in the form of imports. In the Exercises at the end of the chapter you are asked to show that the multiplier in this case is $(z/1 - c(1 - z))$ which may not be greater than 1.

[7] The overall effect may take several months to complete.

[8] Here, however, taxes are exogenous and constant.

Table 10.1 Government Spending Multipliers

	Government consumption Years after change		Government investment Years after change	
	1	2	1	2
Denmark	0.3	0.7	0.7	1.1
France	0.6	1.0	0.8	1.2
Greece	0.5	0.9	0.8	1.2
Belgium	0.3	0.7	0.7	1.1
Germany	0.4	0.8	0.8	1.2
Italy	0.6	1.0	0.8	1.2
Poland	0.4	0.8	0.8	1.2
Portugal	0.4	0.8	0.8	1.2
Spain	0.5	0.9	0.8	1.2
Turkey	0.6	1.0	0.8	1.2
UK	0.5	0.6	0.8	1.2
USA	0.7	0.8	0.9	1.3

Source: OECD (2009). [OECD, *Economic Outlook Interim Report* Appendix 3.2.p. 138 'high estimates']

represent domestic income not *automatically* re-spent on domestic goods and services.

The word 'automatically' is important. For example, some of the additional taxes collected along the way could be used to support additional public spending but it would be an exogenous decision by the government to raise $\overline{G}$ even more than the initial boost $\Delta\overline{G}$. Similarly, higher savings are available to finance new productive equipment. However, firms must be convinced to invest more. Improved expectations of future profitability captured by Tobin's q, which we treat here as exogenous, would do this. Finally, a rise in imports will generate higher incomes abroad, triggering there another multiplier effect which might well lead to higher foreign GDP Y^* and more exports. All of these effects are plausible but, since we consider $\overline{G}$, T, Ω, and Y^* as exogenous, at this stage we cannot logically treat them as responding automatically in the circular flow of income.

It should be clear, by now, that big leakages reduce the multiplier. We can check this a bit more formally. If a large proportion of any additional income is saved or if a large proportion of any additional spending is imported, the *DD* schedule becomes flat. It is easy to see from Figure 10.4 that the flatter the *DD* schedule, the smaller is the multiplier effect.[9]

In practice, there is much debate about the size of the multiplier. A part of the debate, presented in Chapter 20, is associated with doubts about, or even rejection of, the Keynesian assumptions. Another part of the debate is related to more technical issues, for example what is assumed to happen to some of the variables that we have ignored in the previous reasoning (tax revenues, Tobin's q, etc.). Finally, the speed at which GDP responds to fiscal policy actions varies, depending on countries and circumstances. The multipliers presented in Table 10.1 show the effect of an increase in public spending over the following two years and should be regarded as very well-informed guesses. Generally, the multiplier is higher in large and relatively closed economies, like the euro area and the USA, because import leakages are small. These estimates, used by the OECD, also tend to indicate that the multiplier is modest in many cases and not always greater than one.

[9] Using the result in Box 10.2, it is easy to see that a lower c or higher z decreases the multiplier.

10.2.5 Endogenous and Exogenous Variables

When using this framework, we return to the distinction made in Chapter 1 between endogenous economic variables we are trying to explain, versus those exogenous variables we take as given to the analysis. Whether a variable is treated as endogenous or exogenous is an analytical assumption made for convenience. Indeed, by declaring a variable to be exogenous, we free ourselves from the obligation of explaining its behaviour. Naturally, we would like to explain everything at once, but being careful has its rewards. Treating most variables as exogenous is an effective way to get a handle on complex phenomena of interest. Later, it is possibly to endogenize variables considered exogenous by introducing new theoretical mechanisms, i.e. the behaviour of government spending and taxes to changes in output, unemployment, etc.

A review will be helpful at this stage. The Keynesian assumption implies that the price level P is exogenous. Instruments of government spending and taxation policy, such as government purchases $\overline{G}$ and taxes $\overline{T}$, are assumed to be under direct control of the government and thus are also treated as exogenous—hence the overbar symbol.[10] As in Chapter 8, household wealth Ω is also assumed to be exogenous, as are foreign variables such as foreign GDP (Y^*) and the price level (P^*), since they are also not influenced by domestic changes as long as the economy under consideration is small relative to the 'rest of the world'. The nominal and real exchange rates too are also treated as exogenous, although we will change that in the next chapter. Finally, the interest rate and Tobin's q will be endogenized in the next section.

In the end, the only endogenous variable so far is output Y. Two other variables, consumption and the PCA, were also treated as endogenous in so far as they depend on output. This section has provided the first explanation of business cycles. It shows how output responds to changes in the exogenous variables. Figure 10.4 deals with one example, when the government increases public spending. It is good practice to consider each of the exogenous variables, ask what happens when it changes, and trace graphically the effect of these changes on GDP.

10.3 The Goods Market and the *IS* Curve

In this section, we add the interest rate to our list of endogenous variables. In the spirit of general equilibrium analysis, we are seeking to explain output and the interest rate *jointly*. This objective will be achieved by the end of this chapter. To do so, we will continue to use graphical tools to assist us in our reasoning. The two endogenous variables will appear on the figure, output Y along the horizontal axis and the interest rate i along the vertical axis.

10.3.1 From the 45° Diagram to the *IS* Curve

In Figure 10.3, the *DD* schedule shows how desired demand varies when output changes, holding everything else (the interest and exchange rates, Tobin's q, public spending and taxes, private wealth, foreign demand) constant. This is the time to remember that Tobin's q is inversely related to the real interest rate r. When r rises, future profits are more heavily discounted and Tobin's q declines. While expected future profits—animal spirits, as we called them—will be considered exogenous, Tobin's q is now endogenous to the interest rate.

We can now ask: What happens to equilibrium output when the interest rate changes? The answer is given in the first panel of Figure 10.5. The starting point A, where equilibrium is achieved, lies on the desired demand schedule drawn for an interest rate i. Now suppose that the interest rate declines from i to i'. We know that Tobin's q will increase. Looking at the investment function (10.3), we see that investment

[10] We treat net taxes as exogenous for simplicity, for the time being. In the WebAppendix to this chapter, more realistically, taxes are allowed to depend positively on income Y. Indeed, in practice, governments usually set tax *rates*, which implies that tax revenues tend to rise with output and income.

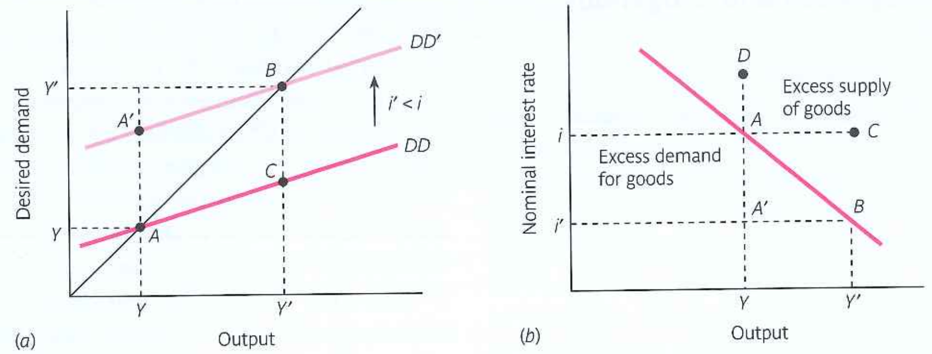

Fig. 10.5 Deriving the *IS* Curve

A reduction in the interest rate from *i* to *i'* leads to an increase in investment spending, which in turn leads to an increase in equilibrium output, as shown in the left-hand side panel. This relation is summarized by the *IS* curve in the right-hand side panel. For a given change in interest rates, the *IS* curve is flatter, the larger is the increase in equilibrium output measured by the horizontal distance between *A'* and *B* in both charts. The length of *A'B* in turn depends on: (1) the sensitivity of demand to interest changes, represented by the size of the vertical shift of *DD*, or *AA'*, in panel (*a*); and (2) the multiplier effect, measured by the horizontal distance *A'B* in the same panel. A steeper desired demand schedule implies greater sensitivity of desired demand to output, larger values of the demand multiplier, and a flatter *IS* curve.

will rise since both of its determinants, the interest rate and Tobin's *q*, act in the same direction. At each level of income, desired demand is now higher, which means that the *DD* curve shifts upwards. The new equilibrium is now achieved at point *B* (with a multiplier effect), which means that equilibrium output increases from Y to Y'.[11]

This result is summarized in the second panel of Figure 10.5. Points *A* and *B* correspond respectively to the initial (interest rate *i* and GDP *Y*) and final (*i'* and *Y'*) situations. Of course, we can repeat the same reasoning for other interest rate levels, to obtain more points like *A* and *B*. They will trace out a negative relationship between the interest rate and equilibrium output depicted by the downward-sloping schedule known as the ***IS* curve**.[12] *For given values of exogenous variables, the IS curve represents the combinations of nominal interest rate i and real GDP that are consistent with goods market equilibrium.*

How do we remember that the *IS* curve is downward sloping? It is enough to remember two things. First, the *IS* curve is the response to the question previously asked: What happens to aggregate demand and equilibrium output when the interest rate changes? Second, a higher interest rate reduces private spending on investment, which reduces demand and, *via* the multiplier, equilibrium output.

10.3.2 The Slope of the *IS* Curve and the Multiplier

What makes the *IS* curve more or less steep? This is not a hugely important issue. Still, we briefly answer the question for the sake of completeness.[13] In Figure 10.5(*b*), the slope of the curve is given by the ratio of *AA'* to *A'B*. *AA'* represents the size of the assumed interest rate reduction, while *A'B* tells us how much equilibrium GDP rises in response to this reduction. Intuitively, the more equilibrium output rises in response to a given reduction of the interest rate, the flatter is the *IS* curve.

11 We can add another channel. A rise in *q* means that stock prices (the price of shares in companies) increases. Since stocks are part of wealth Ω, wealth too increases. This raises private consumption in line with the consumption function (10.2). Thus wealth can be made endogenous as well.

12 The name of this curve comes from the identity (2.6): $I - S = T - G + PCA$, and was first derived by Nobel Prize laureate Sir John Hicks. For simplicity, he assumed government budget balance ($T = G$) and no foreign trade ($PCA = 0$), so the identity can be reduced to $I = S$. We draw the *IS* curve as a line because we do not really know, nor do we need to know, its exact shape. For a derivation of the *IS* curve using calculus, see the WebAppendix.

13 The slope of the *IS* curve is formally derived in the WebAppendix.

In order to understand what determines the size of *A'B*, we turn to panel (*a*). The first item of interest is the upward shift of the *DD* schedule. The vertical distance of the shift corresponds to the initial rise in investment spending generated by the lowering of the interest rate. Obviously, the further up the *DD* schedule shifts, the longer will be *A'B* and the flatter will be the *IS* curve. Thus, the responsiveness of investment to an interest rate reduction is the first factor that influences the slope of the *IS* curve.[14]

Now note that point *A'* in Figure 10.5(*a*) does not correspond to equilibrium in the goods market. Demand has risen, but output has not yet responded. By the arguments we have made all along, supply will rise to meet demand, which increases income and demand. This is the multiplier story all over again. So the second factor that determines the length of *A'B* is the multiplier itself. The larger it is, the longer is *A'B* and, therefore, the flatter is the *IS* curve.

Summarizing, the *IS* curve is flatter (1) the greater the sensitivity of demand to changes in interest rates, as measured by the vertical shift of the desired demand schedule (*AA'*) in panel (*a*), and (2) the larger the multiplier that translates the initial exogenous change into higher total demand, as measured along *A'B*.

10.3.3 Off the *IS* Curve

More interesting is to understand what happens when the economy is *not* on the *IS* curve. The short answer is that the *IS* curve represents the goods market equilibrium condition, so that points off the curve describe conditions of either excess demand or excess supply. But which is which?

Let us start from point *A* in Figure 10.5(*b*), on the *IS* curve, and imagine that output increases while the interest rate remains unchanged—for example, that we move to point *C* vertically above *B*. Spending has risen as well but less because of the leakages discussed in Section 10.2.4. In Figure 10.5(a) demand is represented by point *C* while supply is represented by point B. At point *C* in panel (b), therefore, there is not enough demand to absorb all of the new output. This is a situation of **excess supply** on the goods market, and inventories rise. Similarly, moving vertically up from point *A* to a point like *D* corresponds to an increase in the interest rate at unchanged output. This also leads to excess supply in the goods market because the higher interest rate reduces aggregate demand.

Thus the *IS* curve determines two regions: (1) above and to the right we observe excess supply in the goods market—inventories are being accumulated; and (2) below and to the left, we have **excess demand** in the market for goods and services, and inventories are run down. At the boundary of the two regions, the *IS* curve represents those combinations of GDP and the interest rates which are consistent with goods market equilibrium. We have seen in Section 10.2.2 that the economy can stay temporarily off the *IS* curve, while firms use their inventories as a buffer stock, but fairly soon they will adjust their output, returning the economy to goods market equilibrium on the *IS* curve. For example, from point *C* in Figure 10.5(*b*), the economy will move to point *A* as firms cut production after a period of inventory accumulation. Similarly, from point *D* the economy will move horizontally to the left until it reaches the *IS* curve. More generally, on the right of the *IS* curve where there is excess supply, goods market equilibrium requires that the economy shifts to the left so that output is brought down to a level compatible with desired demand. Conversely, starting from a situation of excess demand on the left of the *IS* curve, the economy will move to the right as firms expand output to meet demand. This is what the Keynesian assumption implies.

10.3.4 A Key Distinction: Movements Along or Shifts of the *IS* Curve

A common pitfall for students is to confuse *shifts* of the *IS* curve with movements *along* it. This is directly related to the distinction between exogenous and endogenous variables examined in Section 10.2.5. The *IS* curve describes how the two endogenous variables, the real GDP (*Y*) and the nominal interest rate (*i*), are combined to achieve equilibrium in the goods market, *everything else being held constant*. What is 'everything else'? All the variables that we treat as exogenous when we draw the *IS* schedule. As long as these exogenous variables remain constant, the *IS*

14 We noted in footnote 11 that consumption is also likely to rise. The more it does, the flatter will the *IS* curve be.

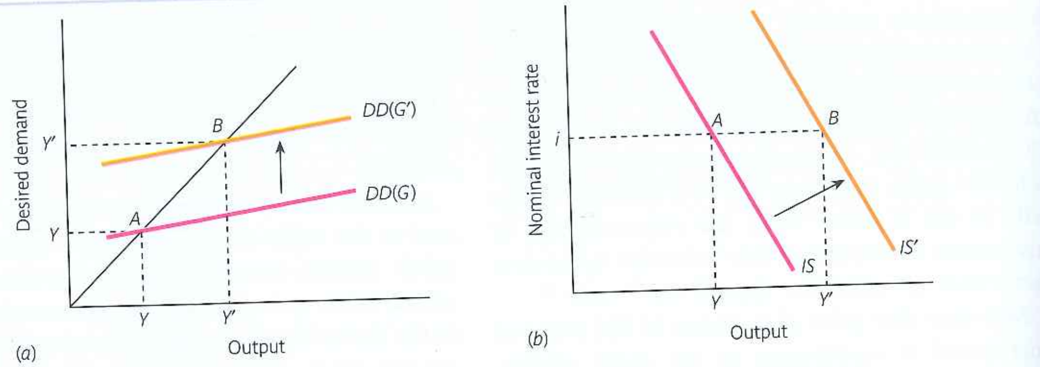

Fig. 10.6 An Exogenous Increase in Aggregate Demand

At unchanged interest rate *i*, an increase in any of the exogenous components of demand is represented in panel (*a*) by an upward shift of the aggregate demand schedule. Equilibrium occurs at point *B* and the new equilibrium output *Y'* is higher than the initial level *Y*. Panel (*b*) shows that the *IS* curve shifts to the right at the given interest rate.

curve stays in place and we can only move along the curve. Any change in any exogenous variable, however, causes the *IS* to shift.

In Figure 10.6, an example shows what happens when desired demand increases exogenously, e.g. if public spending is increased, or the real exchange rate depreciates. In both panels, we start from point *A*, with output Y and interest rate *i*. In panel (*a*), the desired demand schedule shifts upwards. Then the multiplier process gets under way and we eventually

Box 10.3 The American Dream, An American Nightmare

A home or an apartment is an important acquisition for anyone, and as a rule, households hold most of their wealth in their house. Most households purchase houses on credit, a long-term loan called a mortgage. Recent changes in regulation of the way lending is conducted given for house purchases around the world, and especially in the USA, led to new ways to shift income to the present by borrowing more money to purchase the house, and second, to convert additional house value after the purchase (home equity) into cash today by borrowing against it. Effectively, this deregulation made it easier to behave like the consumers with access to credit markets, as described in Chapter 8.

Assuming that households ultimately respect their intertemporal budget constraints and repay their mortgages, these changes can make them better off. Yet in a world of uncertainty it is possible for consumers to borrow too much. Low interest rates in the early 2000s led to excessive borrowing and a run-up of house prices never seen in US history. The first panel of Figure 10.7 shows how dramatic that increase was. It plots a price index of the average value of houses in key US cities divided by the consumer price index. As an average, it masks the fact that some regions experiencing increased of house prices of 300% and more over the period 1990–2007. Many consumers regarded this increase in wealth as long-lasting and took out loans guaranteed by their new-found wealth to finance additional consumption.

After 2007, house prices dropped dramatically as owners of second and third homes rushed to sell and insolvent borrowers walked away from their loans. As property values declined, the value of wealth declined, so the basis for consumer loans dried up, while banks toughened lending requirements. The result was not only the deepest recession since the 1930s, but also a drop in consumption given income, meaning that households were tightening their belts, more than would have been expected given the recession. This is shown by the second panel which shows the behaviour of consumption around its long-run trend which prevailed from 1970–1995.

end up at point *B*, where output is *Y'*. Now remember that the interest rate is exogenous for panel (*a*). Implicitly, therefore, we have assumed that it has not changed and that is the same at points *A* and *B*. Now transcribe this into panel (*b*). Point *B* corresponds to the same interest rate *i* and to the new output level *Y'*. This point lies on the new curve *IS'*, which shows how the curve has shifted. In the end, the rule is simple: any exogenous change that raises aggregate demand shifts the *IS* curve to the right, which quite logically means more output. Conversely, when demand exogenously declines, the *IS* curve shifts to the left.

Which are the relevant exogenous variables? Fiscal policy is a premier source of shifts in the *IS* curve. The government is a large player in the macroeconomy, and changes in government purchases of goods $\bar{G}$ (e.g. military procurement or road construction) or services (e.g. the number of civil servants or their pay packets) exerts a significant influence on aggregate demand. Similarly, changes in taxation $\bar{T}$ alter disposable income available to households or firms, with knock-on multiplier effects on consumption.

Second, consumption depends on household wealth Ω. Wealth can take many forms, such as land, apartments and houses, financial assets, precious goods such as jewels, Persian rugs, and art, etc. Several of these components can be highly volatile and provoke sharp changes in consumption and thus the position of the *IS* curve. A classic example is the Great Depression of the 1930s, which followed the crash of stock prices on Wall Street. Many recessions in the past century have been associated with sharp increases of asset prices, increases in consumption spending, and subsequent collapse. The global financial crisis (2008–2009) was driven by a collapse of overvalued house prices in the United States and some other countries. It serves as an excellent example of how a collapse of wealth can affect consumption. Box 10.3 gives details.

Third, changes in expectations of the future can have dramatic effects on investment decisions of businesses. Keynes spoke of 'animal spirits'—business expectations driven by gut feelings or observing others, as opposed to rational calculations. These

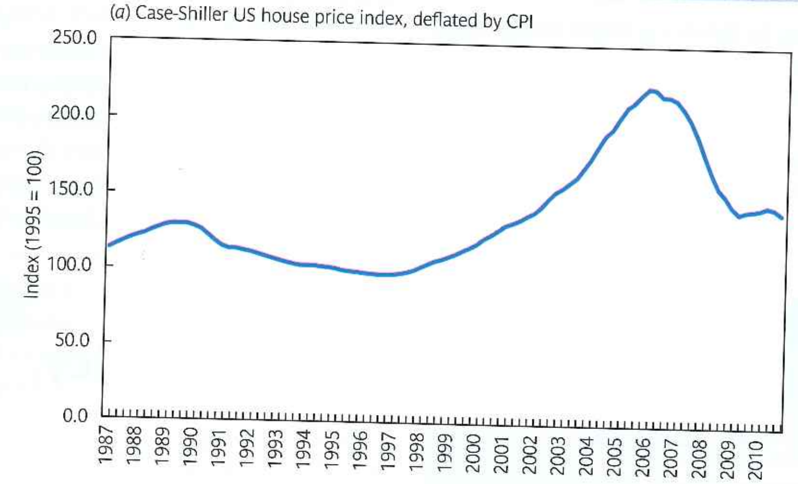

Fig. 10.7 Consumption and House Prices in the USA, 1987–2010

Because dwellings constitute a significant component of household wealth, consumption is strongly influenced by the valuation of apartments and houses. This can be seen in data from the Great Recession in the United States. The upper panel plots the Case–Shiller Home Price Index, which measures the evolution of average housing prices in the USA, divided by the consumer price index. It has been normalized to take the value 100 in 1995. The lower panel shows the deviation of consumption expenditures, in per cent, from a long-term trend. The plot shows not only a dramatic drop in consumption following the collapse of house prices after 2007, but it also shows a rise in the late 1990s, which is likely related to both the steady rise in house prices as well as a stock market boom at that time.

Sources: Standard & Poor/Case–Shiller, *OECD*; authors' calculations.

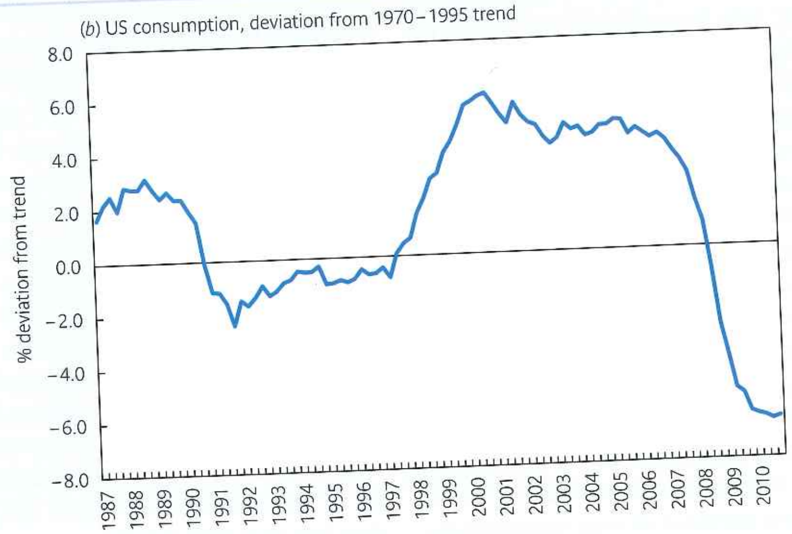

Fig. 10.7 (Continued)

expectations of the future profitability of investment—correct or not—are captured in Tobin's q. An increase in Tobin's q implies an increase in investment at any level of investment spending, and means that the *IS* curve shifts out at any interest rate. Similarly, a decline in Tobin's q would imply lower investment expenditures at any level of interest rates and an inward shift of the *IS* curve.

Finally, foreign disturbances matter for an open economy. They affect the *IS* curve through the primary current account. The current account is not only a source of leakage, but it also transmits foreign disturbances. Indeed, the PCA function (10.8) shows that changes in world activity Y^* can generate export-led expansions or recessions. All other things equal, an increase in Y^* will increase the PCA and cause the *IS* curve to shift rightwards. The same applies to the real exchange rate $\sigma = SP/P^*$, which determines the economy's competitiveness. Any change in either the nominal exchange rate S or in domestic and foreign prices P and P^* will affect the real exchange rate σ and shift the *IS* curve. A real exchange rate depreciation (σ falls) implies a rightward shift of the IS curve; a real exchange rate appreciation moves the *IS* curve leftwards.

10.4 The Money Market, Monetary Policy, and the *TR* Curve

10.4.1 The Taylor Rule and the *TR* Curve

After studying the goods market in Section 10.3, we turn to the money market. There, banks interact with households and firms, and the demand for money is equilibrated with its supply. In the same way as before, we look for levels of real GDP and interest rate which represent equilibrium in the money market. In Chapter 9, we saw that a central factor of the money market is the conduct of monetary policy by the central bank. Central banks can either try to control the quantity of money in the market, or the level interest rates for short-term lending by banks among themselves. They cannot control both.

Nowadays, central banks conduct monetary policy by setting certain interest rates directly in the money market, and the economy adjusts accordingly.

Effectively, this is the equivalent of a money supply curve. In Chapter 9, we showed that central bank interest rate policy is well-tracked by the **Taylor rule**. The Taylor rule states that the central bank increases the interest rate relative to the 'neutral level' if the inflation rate rises relative to its target rate, or if output rises relative to its trend level. The neutral—sometimes also called natural—interest rate is the one that would be chosen by central bank if inflation and output were both on target. The Taylor rule presented in Section 9.4. stated that the interest rate setting policy of modern central banks can be represented by the following relationship:

$$i = \bar{i} + a\underbrace{(\pi - \bar{\pi})}_{\text{inflation gap}} + b\underbrace{\left(\frac{Y-\bar{Y}}{\bar{Y}}\right)}_{\text{output gap}} \qquad (10.10)$$

where π is the inflation rate, $\bar{\pi}$ is the central bank's inflation target, and $\bar{Y}$ is trend GDP. Recall that $\bar{i}$ is the neutral—sometimes also called natural—interest rate, which the central bank would choose if inflation and output were both on target ($\pi = \bar{\pi}$ and $Y = \bar{Y}$). The coefficients a and b indicate how responsive the central bank is to inflation and the output gap, respectively.

In the short run, the neutral interest rate $\bar{i}$ is a policy variable of the central bank. It is the anchor of the Taylor rule which summarizes the central bank's monetary stance.[15] For that reason we will also call it the **target interest rate** of the central bank. The Taylor rule will be simplified in this and the next chapter because we make the Keynesian assumption that prices are constant, i.e. that both inflation and its target rate are zero ($\pi = \bar{\pi} = 0$).[16] Under these assumptions, we can write the Taylor rule in the following simple form:

$$i = \underbrace{\bar{i}}_{\text{target interest rate}} + b\underbrace{\left(\frac{Y-\bar{Y}}{\bar{Y}}\right)}_{\text{output gap}} \qquad (10.11)$$

which says that central bank policy 'leans against the wind': it raises the interest rate whenever output Y increases relative to potential output and, conversely, cuts rates when Y declines.[17] Monetary policy conducted by the central bank is centred around $\bar{i}$, the nominal interest rate which the central bank would choose if the economy were at its equilibrium or trend level of output.

Just as the *IS* curve shows combinations of interest rate and output consistent with goods market equilibrium, the Taylor rule gives rise to a combinations of output and interest rates which characterize the monetary policy of the central bank. Combined with a demand for money, we can describe the interaction of the Taylor rule and the demand for money as representing money market equilibrium. This will be discussed in more detail later. This set of pairs of interest rates and output consistent with central bank's monetary policy as summarized by its Taylor rule is called the ***TR* curve.** The *TR* curve is shown in Figure 10.8. It is upward-sloping because a higher level of GDP, all other things equal, causes the central bank to raise interest rates. A lower level of GDP prompts interest rate cuts by the central bank. When the economy is at its trend level, the

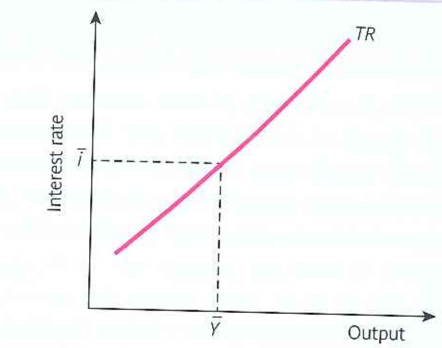

Fig. 10.8 The *TR* Curve

The central bank sets interest rates according to a Taylor rule. Since inflation is treated as exogenous in the short-run analysis, the level of output plays a larger role for the Taylor rule. When output rises relative to its trend level, central banks tend to lean against the wind, i.e. raise interest rates, while they cut interest rates in recessions.

[15] In the long run, this will not be the case. Chapter 13 goes into detail on this crucial point.

[16] While Keynesian analysis often assumes inflation equal to zero, this is not necessary for most of the analysis which follows.

[17] To simplify the graphical analysis in this chapter and the next, we will consider only absolute deviations from trend output.

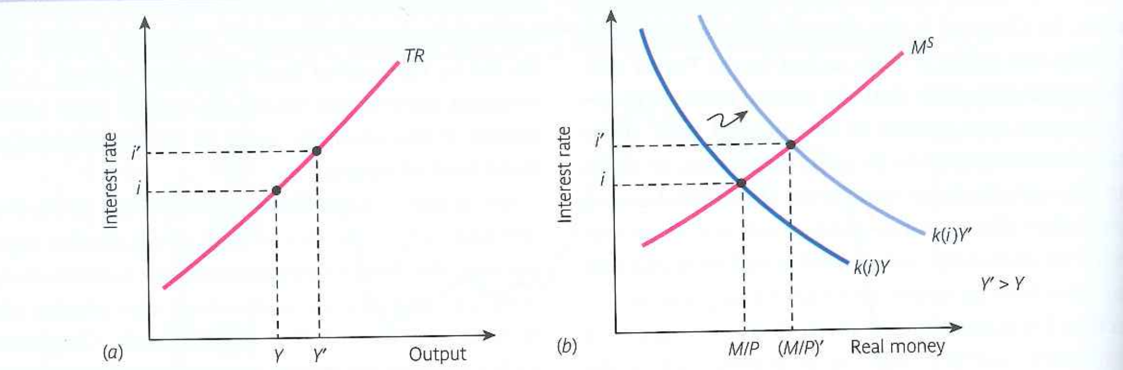

Fig. 10.9 The *TR* Curve and Money Market Equilibrium

When GDP increases, the *TR* curve implies an increase in interest rates as dictated by central bank policy in panel (*a*). At the same time, increased GDP and income lifts the demand for money; in panel (*b*), the demand curve for money has shifted to the right. As a result, the money supply has increased from M/P to (M/P)′. The money market is equilibrium with the central bank supplying the money demanded at the higher level of output and interest rates.

interest rate set by the central bank is equal to its target rate $\bar{i}$.

Because the *TR* curve describes how the central bank behaves, the economy is *always* on it, in contrast to the *IS* curve, where we saw that there can be excess demand and supply of goods. Money market equilibrium is depicted in panels (*a*) and (*b*) of Figure 10.9. Panel (*a*) reminds us that the central bank chooses the interest rate that its Taylor rule dictates, but it must then provide the amount of bank reserves that the market demands at that interest rate.[18] Graphically, demand and supply must be equal when the central bank chooses a point along the money demand curve. This is captured by the right hand panel (*b*) of the figure. In order to steer the interest rate to its chosen level, the central bank must supply the amount of money that corresponds to the chosen interest rate and the level of output associated with it. This supply of money traces out as the M^S curve in panel (*b*).

10.4.2 Slope of the *TR* Schedule

The slope of the *TR* schedule shows how vigorously the central bank reacts to the output gap, raising the interest rate when the output gap is positive and cutting it when the gap is negative. In fact, this vigour of response is summarized completely by the parameter *b*. To see this, compare different monetary policies symbolized by TR curves TR_0, TR_1, and TR_2 in panel (*a*) of Figure 10.10. TR_2 corresponds to the most vigorous interest rate reaction (points B and F), followed by TR_1 (points C and E). TR_0 corresponds to a constant interest rate policy ($b = 0$).

In Figure 10.10, curve TR_2 corresponds to the case when the money supply does not change at all. The central bank refuses to supply any new reserves to the money market. This type of policy is called **monetary targeting**. It implies large fluctuations of interest rates in money market equilibrium in response to swings in GDP, and corresponds to a much steeper *TR* curve. This is drawn as points B and F in the panels of Figure 10.10.

Even if it is no longer practiced, monetary targeting has a special role in both the theory and practice of macroeconomic policy. In the original analysis of Keynes' ideas, the money supply was fixed by the central bank. Monetary policy was summarized by the *LM* curve, which is still used by many instructors of macroeconomics today. It is discussed in Box 10.4. The general case is represented by the upward-sloping schedule TR_1 in panel (*a*) of Figure 10.10. It says that the central bank adjusts the supply of money as GDP fluctuates.

18 We saw in Chapter 9 that different central banks employ different 'battle tactics' (open market purchases and sales, rediscounting), but they all have the same overall objective—setting the market interest rate at some target level.

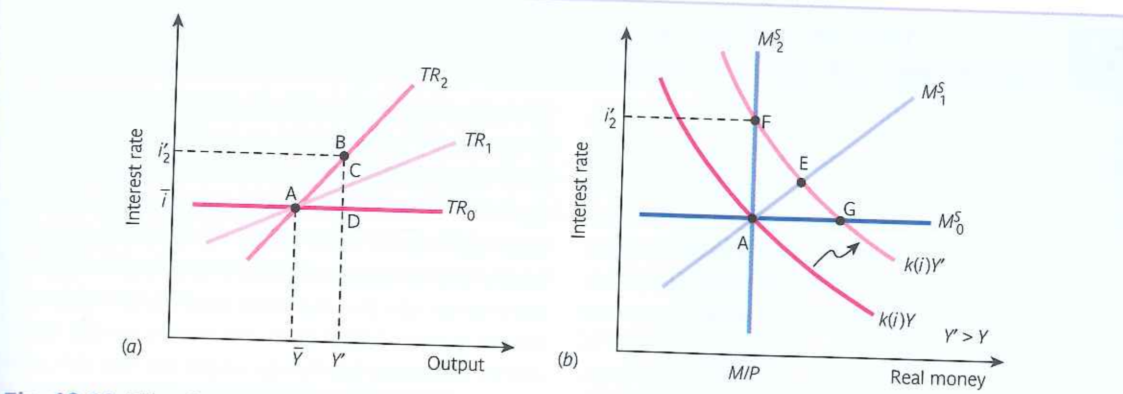

Fig. 10.10 The Slope of the *TR* curve

Different slopes of the *TR* curve correspond to different degrees to which central banks lean against the wind and raise interest rates in light of an economic expansion, or cut them as output declines. As output increases from *Y* to *Y*′, different *TR* curves will imply different interest rates. TR_2 depicts the most stringent of monetary policies, involving sharp increases in response to increasing output. TR_1 corresponds to less-sensitive monetary policies, while TR_0 implies that interest rates are held constant. Each *TR* curve implies a different supply of money consistent with the interest rate chosen by the central bank. TR_0 implies the largest increase in the money supply; TR_2 is constructed to imply an unchanged money supply in response to the increase in GDP.

Box 10.4 Twentieth-Century Keynesian Analysis of Money Market Equilibrium: *LM* curve

Keynes wrote the *General Theory* in the depths of the Great Depression. The idea of studying the demand and supply for money as the primary determinants of interest rates—as opposed to the demand and supply for loans on the other side of banks' balance sheets—was revolutionary. Keynes' analysis consisted of a couple of equations, and there was little graphical analysis to help. At the time, it seemed plausible to assume that central banks could exert close control over the money supply. Against this backdrop, in 1937 the eminent contemporary of Keynes, the Oxford economist and Nobel Laureate J.R. Hicks, clothed Keynes' ideas in mathematical garb, summarizing money market equilibrium as the equality of a money supply under the control of the central bank and Keynes' 'liquidity preference'—the demand for money described in Chapter 9. He also developed a graphical framework, which was used for many decades: the *IS*–*LM* diagram. It is the precursor of the *IS*–*TR* analysis in this book.

For a constant money supply, this money market equilibrium can be depicted in the same panels of Figure 10.10 used to derive the *TR* curve. Starting from point A, we consider on the right-hand side the intersection of the demand for money, *k*(*i*)*Y*, and the supply of money (*M*/*P*):

$$M/P = k(i)Y. \tag{10.12}$$

Hicks' thought experiment was to ask if there are other combinations of output and interest rates consistent with money market equilibrium for a given amount of money supply. Put differently, what happens to money market equilibrium if GDP rises from *Y* to *Y*′, holding all else constant? The demand for money rises as firms and households need more to carry out increased volume of transactions. As is evident from panel (*b*), an increase in *Y* keeping *M* constant increases the equilibrium interest rate. Indeed, the supply has not changed so the interest rate must rise to fully offset the effect on demand of higher output. From panel (*a*), this implies a

Box 10.4 Twentieth-Century Keynesian Analysis of Money Market Equilibrium: *LM* curve (*Continued*)

second pair of equilibrium combinations of output (GDP) and interest rates which are consistent with money market equilibrium (Y_2' and i_2') which are on the TR_2 curve in panel (*a*). Hicks called this positive relationship between GDP and the interest rate for a given money supply the *LM curve*.[19] The *LM* curve is upward-sloping because when the central bank targets the money supply, rising interest rates are necessary to restore money market equilibrium in the wake of an increase in GDP (i.e. real income and output), which raises the demand for money.

Until the 1990s, the *LM* curve was the standard textbook description of short-run money market equilibrium. Combined with the *IS* curve (also due to Hicks), it formed the basis of undergraduate education for millions of economics students and analysts. The *IS*–*LM* asked what happens when the money supply is fixed. Yet the question remained: What will be the central bank's response? The *LM* curve can be thought of as a special case of the *TR* curve in which the central bank chooses the interest rate that maintains a constant money supply, for a given output level. For a time, central banks did try to control the money supply and the *LM* curve was the right way to think about the macroeconomy. Now that most central banks set interest rates directly and behave according to the Taylor rule, the *LM* curve has lost its usefulness as a pedagogical device and will not be used in this textbook.

10.4.3 Monetary Policy: Moving Along or Shifting the *TR* Curve

As with the *IS* curve, it is important to distinguish between movements along or shifts of the *TR* curve. The *TR* curve represents the monetary policy of the central bank, so it only moves *when that policy itself changes*. At this stage of the analysis, the central bank's Taylor rule (10.10) is summarized by two parameters. The first is the slope of *TR* curve, given by *b*. This shows the strength of central bank's reaction of output moving from its trend, and corresponds to the underlying objectives of the central bank in 'leaning against the wind' and preventing swings of output. The second key parameter is the central bank's target interest rate $\bar{i}$. This is the desired level of interest rate at a 'normal' level of output. For reasons explained in more detail in Chapter 13, $\bar{i}$ is also sometimes called the central bank's estimate of the **short-run neutral interest rate**.[20]

Unless $\bar{i}$ changes, the economy moves along the *TR* schedule. Thus, an increase in GDP, holding all else

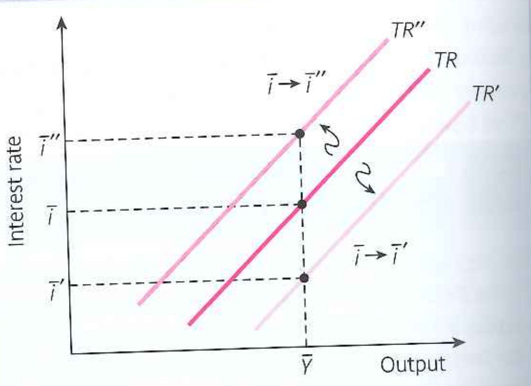

Fig. 10.11 Shifts of the *TR* curve

If the central bank reduces its target rate from $\bar{i}$ to $\bar{i}'$, the *TR* schedule shifts downwards and to the right. When output equals trend level at $\bar{Y}$, the interest rate was set at $\bar{i}$; now it is set at to $\bar{i}'$. This is an example of expansionary monetary policy. A contractionary policy would correspond to an increase in the target rate to $\bar{i}''$.

[19] The name '*LM*' originates from the fact that, along the curve, the demand for liquidity (*L*) equals the money supply (*M*) in equation (10.12). For an explicit derivation of the slope of the *LM* curve using calculus, see the WebAppendix to this chapter.

[20] In Chapter 13 we will see that in the long run, the neutral interest rate must be equal to the sum of the equilibrium real interest rate *r* plus the target rate of inflation. In the short run, central banks can choose the target interest rate to deviate from this long run condition.

constant, will be associated with higher interest rates, while lower GDP will induce the central bank to reduce interest rates. When the values of those parameters do change, the *TR* curve will change position. One possibility is an increase in *b* which would cause the *TR* curve to rotate around the point defined by trend GDP $\bar{Y}$ and the target interest rate $\bar{i}$, as shown in Figure 10.10, say from TR_1 to TR_2. This would imply that the central bank is more concerned about reducing output fluctuations.

A second possibility is that the central bank changes its target interest rate, for instance reducing it from $\bar{i}$ to $\bar{i}'$. This would imply a downward shift of the TR schedule from *TR* to *TR'* in Figure 10.11. At any level of output, the central bank will now choose a lower interest rate; as we will see shortly, this means a more expansionary monetary policy. Similarly, the central bank could decide to raise interest rates at any level of output. This would imply an upward and leftward shift of the TR curve.

10.5 Macroeconomic Equilibrium

We are now ready to study the macroeconomy when both goods and money markets are in equilibrium. The resulting framework will provide a useful tool for understanding how output and the interest rate respond to exogenous disturbances. This is an important step forward. Indeed, in Section 10.2, on the basis of an analysis of the goods market, we had developed a way to understand the behaviour of the output gap, our initial interpretation of business cycles. Section 10.3 derived combinations of output and interest rates consistent with a goods market equilibrium under the Keynesian assumption; Section 10.4 did the same for money market equilibrium, given that the central bank's behaviour follows a Taylor rule. We now ask under which conditions *both* goods and money markets are in equilibrium *at the same time*. In effect, we are imposing mutual consistency on the two markets as a condition for macroeconomic general equilibrium. The next step will be to analyse the effects of changes in exogenous influences on output and interest rates.

10.5.1 Macroeconomic Equilibrium in the *IS*–*TR* Model

For the time being, we ignore the exchange rate and the fact that the economy may be subject to financial flows. This is a good characterization of the equilibrium of the global economy for which the current account is zero, or a large economy subject to controls on movements of financial capital. Deficits and surpluses on the current account (PCA less than or greater than zero) are financed passively by financial markets. In the next chapter, the objective is to show how things change when we consider an economy open to active financial flows.

Using the *IS*–*TR* apparatus is straightforward. We have seen that the economy cannot stay for long off the *IS* curve and that it is always on its *TR* curve. So, for both goods and money markets to be in equilibrium simultaneously, we require that the economy lies at the intersection of the *IS* and *TR* curves. In Figure 10.12, macroeconomic equilibrium is achieved at that intersection, point *A*. At this point there is neither excess demand for nor supply for goods, nor is there excess demand for or supply of money, given the central bank's policy summarized by the Taylor rule.

To help understand this powerful notion of equilibrium, it is useful to remind ourselves what other combinations of output and interest rates would imply. All other points in the diagram which are off the *IS* and *TR* curve represent either disequilibrium in the goods market, an inconsistency of monetary policy with the Taylor rule, or both. All points above the *IS* curve imply an excess supply of goods, while all points below it imply an excess demand for goods. Similarly, all points above the *TR* curve imply that interest rates are above the level consistent with the central bank's monetary policy—the central bank can be expected to take action to reduce them. For all points below the *TR* curve, the central bank can be expected to raise interest rates.

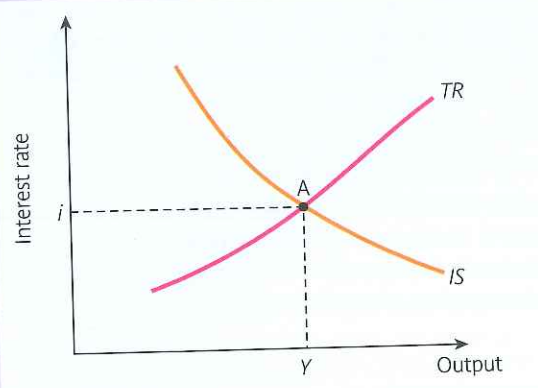

Fig. 10.12 Macroeconomic Equilibrium
Macroeconomic equilibrium occurs when both the goods and money markets are in equilibrium simultaneously. This occurs at the intersection of the *IS* and *TR* curves at point *A*.

10.5.2 Real Shocks: Shifts of the *IS* curve

We can use the *IS–TR* framework to understand the effects of exogenous disturbances, or **shocks**, to the macroeconomy. These shocks can originate either in the real side of the economy or from the monetary side of the economy. They may originate at home or abroad. In the *IS–TR* diagram, shocks are captured as shifts of one curve or another. In this section, we consider shocks to the goods market–shifts of the *IS* curve. The reasoning applied will be to ask: After the shock occurs, where is the *new* curve in relation to the original one?

Consider, for example, the effect of an exogenous change in government purchases of goods and services, $\bar{G}$, say, an increase from $\bar{G}$ to $\bar{G}'$. This corresponds to the type of action taken in the wake of the Great Recession in 2008–9. For example, the government might increase spending on schools—teachers, computers, or classrooms.[21] Starting from *IS* in the first panel (*a*) of Figure 10.13, an exogenous increase in government spending makes every point previously consistent with goods market equilibrium now out of equilibrium. In fact, for every point on the old *IS* curve, aggregate demand now exceeds output. Logically, the exogenous increase in government spending implies that the new curve should lie to the right of the old *IS* curve; there is an exogenous increase in the demand for goods at any level of interest rate, which is met by a greater supply. This shift is shown as the shift from *IS* to *IS′* in panel a) of Figure 10.13. The new equilibrium occurs at point *B*. An exogenous increase in demand leads to a higher output and a higher interest rate.

This is an interesting result in its own right, but it is just as important to understand what is happening in the background. First, higher demand results in higher output. After all, the Keynesian hypothesis is that output responds to demand. But there is more to the outcome than that. We know that the *IS* curve rightward shift is larger than the initial boost in demand because of the multiplier effect. So we know that the total increase in output results from a succession of impulses running from more demand to more output, and from more output to more income and therefore yet more demand.

Second, the interest rate has increased. This is because the *TR* curve is upward-sloping. By assumption, the position of the *TR* curve has not changed, because the factors that determine its position remain unchanged. Therefore, we move with the *IS* curve *along* the *TR* curve. As output rises, the monetary authority raises interest rates. Because interest rates have risen, output rises less than it would have under a situation of constant interest rates. This example illustrates how considering the feedback from the goods market to the money market imposes consistency on the overall macroeconomic outcome.

Exogenous shifts in components of real aggregate demand have effects which are qualitatively similar to shifts to government spending. It is possible to identify a number of factors behind the *IS* curve which can be the source of exogenous shifts of aggregate demand, given income. Besides government purchases $\bar{G}$, these include:

- taxes (net of transfers) $\bar{T}$
- household wealth Ω
- Tobin's q

[21] We will consider the increase in government spending as $\bar{G}$ irrespective of whether it is government consumption or investment. Table 10.1 suggests that this aspect may be relevant in practice.

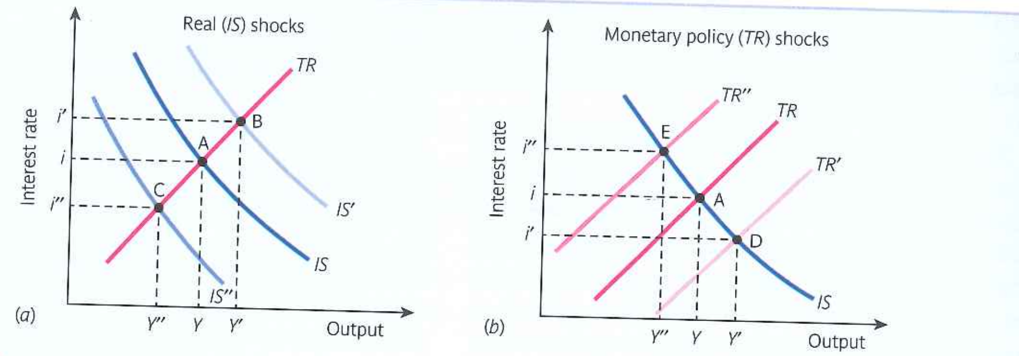

Fig. 10.13 Macroeconomic Shocks
In panel (*a*), starting from point *A*, an exogenous increase in demand shifts the *IS* curve to *IS′*. This takes the economy to point *B* along the *TR* schedule, which shows that the central bank raises the interest rate in response to output expansion. An exogenous decrease in demand shifts the *IS* curve to *IS″*, leading to lower interest rates and output. In panel (*b*), an expansionary monetary shock, an exogenous cut in the target interest rate, moves the *TR* curve to *TR′*, leading to greater output and lower interest rates; a contractionary monetary shock raises interest rates and reduces output.

- the real exchange rate σ
- foreign income Y^*.

To understand the direction of the shift implied by exogenous changes in these variables we merely need to think about the impact they would have on aggregate demand given output (*Y*). An increase in taxes ($\Delta\bar{T} > 0$) shifts the *IS* curve to the left, since this would reduce aggregate demand at every level of output or interest rates; a tax cut ($\Delta\bar{T} < 0$) shifts the *IS* curve up and to the right. An exogenous increase in Tobin's q ($\Delta q > 0$) would lift investment expenditures for any level of output and income, shifting the *IS* curve to the right; a drop in Tobin's q ($\Delta q < 0$) shifts the *IS* curve to the left. A rise in the real exchange rate ($\Delta\sigma > 0$) reduces international competiveness and reduces net exports, depressing aggregate demand and shifts the IS curve to the left, while a decrease ($\Delta\sigma < 0$) would raise aggregate demand and shift the *IS* to the right. Finally, an exogenous increase in household wealth Ω causes households to increase their consumption at all rates of interest, shifting the *IS* curve to the right, while a decline in wealth causes the *IS* curve to shift to the left. The last event is highly relevant for understanding the impact of the financial crisis on the real economy in all countries, but especially those which were hit by the end of the real estate bubble of the 2000–2010 decade, as discussed in Box 10.3.

10.5.3 Monetary Policy Shocks: Shifts of the *TR* curve

Now consider another thought experiment. The central bank decreases its target neutral interest rate, an example of an **expansionary monetary policy shock.** This means that at any level of output, the central bank will fix the nominal interest rate at a lower level than before. This policy change is represented as an exogenous decline in the target interest rate from $\bar{i}$ to $\bar{i}'$, with $\bar{i}' < \bar{i}$.

This event is tracked in panel (*b*) of Figure 10.13. Graphically, the *TR* curve shifts down to *TR′*, and the economy moves from point *A* to point *D*. The outcome of this expansionary monetary policy is higher output and a lower interest rate. As the central bank provides more liquidity, banks can lend to customers at lower interest rates. Why do bank customers wish to borrow more? Because interest rates are lower. With a lower interest rate, investment spending rises and we move down and to the right along the *IS* curve. As we do so, the multiplier takes over and consumers start spending more because their incomes rise. Note, however, that the equilibrium interest rate does not