2

Output and Expenditure

We begin with static models of the real economy at the aggregate level, abstracting from money, prices, international linkages and economic growth. Our causal perspective depends on what we consider to be held fixed, or exogenous. In the *short-run* the output of the economy is determined by the level of expenditure, which is made up of three components: private consumption, investment and government spending. These components of expenditure are in turn determined by variables like taxes and the real interest rate, which are considered to be exogenous. This is the “Keynesian” perspective. But in the *long-run* output is exogenous, being determined by the level of employment of the factors of production: capital and labour. This is the “classical” perspective, in which the real interest rate adjusts to bring expenditure into line with the given level of output.

An issue that arises under both the long- and the short-run is how to treat the public sector balance, or the government financing constraint. Without a financial sector in the model there is no mechanism to accumulate debt, so strictly speaking the government budget must be balanced. From a long-run perspective this is as it should be, but should a balanced budget be imposed in the short-run too? It could be argued that if the financial consequences of a government surplus or deficit have little impact on the real economy in the short-run, they can be ignored. Below we present the simple short-run model in both versions, with an unbalanced budget and with a balanced budget. The different consequences show how important the assumption is.

2.1 IS model with taxes in the short-run

A linear version of a simple standard textbook model of the real macro economy comprises the following equations:

$$E = C + I + \overline{G} \tag{1}$$

$$Y = E \tag{2}$$

$$C = C_0 + cY^d \tag{3}$$

$$Y^d = Y - T \tag{4}$$

$$T = T_0 + tY \tag{5}$$

$$I = I_0 - a\overline{R} \tag{6}$$

where E is expenditure, Y is total output or GDP, C is consumers' expenditure, I is investment, G is current spending by the Government, Y^d is disposable income, T is taxes and R is the real interest rate. A bar over a variable indicates that the variable is exogenous, and variables labelled with zero subscripts—intercepts—are "shift parameters" or "exogenous shocks" to the equations in which they appear.

A flowgraph of the IS system is displayed in Figure 2.1. It is constructed by assuming that the left-hand side variable in each equation is determined by that equation. Our causal understanding is only ambiguous about the income-expenditure "identity" (1), but since each component of expenditure is determined by the other equations in the system, it is only the total that can be determined by that equation. Thus the topography of the flowgraph is uniquely determined by our causal understanding of the model. How the graph is actually laid out is a matter of choice: the principal criterion should be its intelligibility. In the case of Figure 2.1(b), the layout was selected bearing in mind the intention to add on a graph of the LM system later.

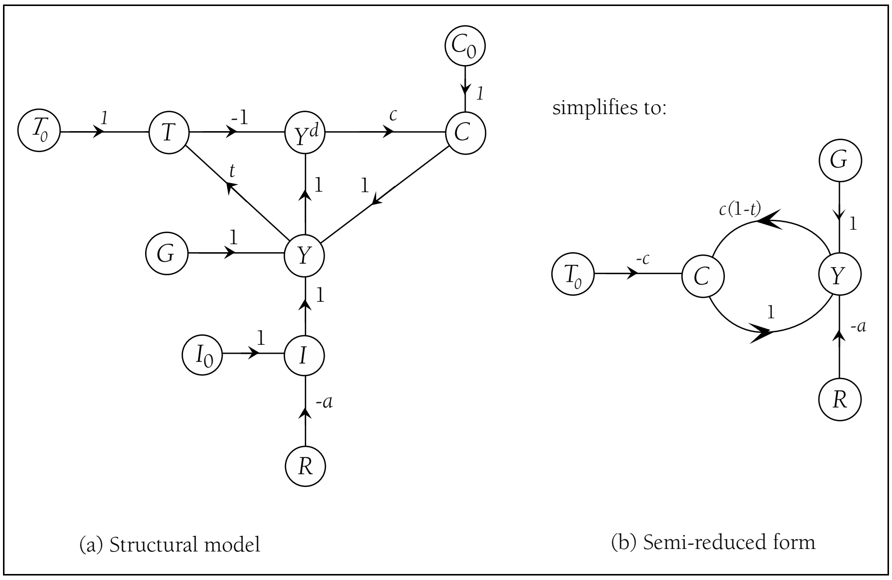


Figure 2.1 The IS subsystem

The flowgraph in Figure 2.1(a) displays the full detail of the model from the causal transcription of the equations. However, in practical work it is desirable to keep only the essential detail needed for the purpose in hand, and by absorbing the intermediate variables *T*, Y^d and *I* according to the rules set out in Chapter 1, and ignoring the shift parameters I_0 and C_0, the flowgraph simplifies to that shown in Figure 2.1(b), where the one loop L=$c(1–t)$ implies the system determinant $\Delta=1–c(1–t)$, and Mason's rule immediately gives the familiar Keynesian multiplier formulae:

$$\frac{dY}{dT_0}=\frac{-c}{1-c(1-t)},\quad \frac{dY}{dG}=\frac{1}{1-c(1-t)},\quad \frac{dY}{dR}=\frac{-a}{1-c(1-t)}$$

$$\frac{dC}{dT_0}=\frac{-c}{1-c(1-t)},\quad \frac{dC}{dG}=\frac{c(1-t)}{1-c(1-t)},\quad \frac{dC}{dR}=\frac{-ac(1-t)}{1-c(1-t)}$$

The standard diagrammatic representation of the IS system as found in macroeconomics textbooks (the "Keynesian cross") is reproduced as Figure 2.2.

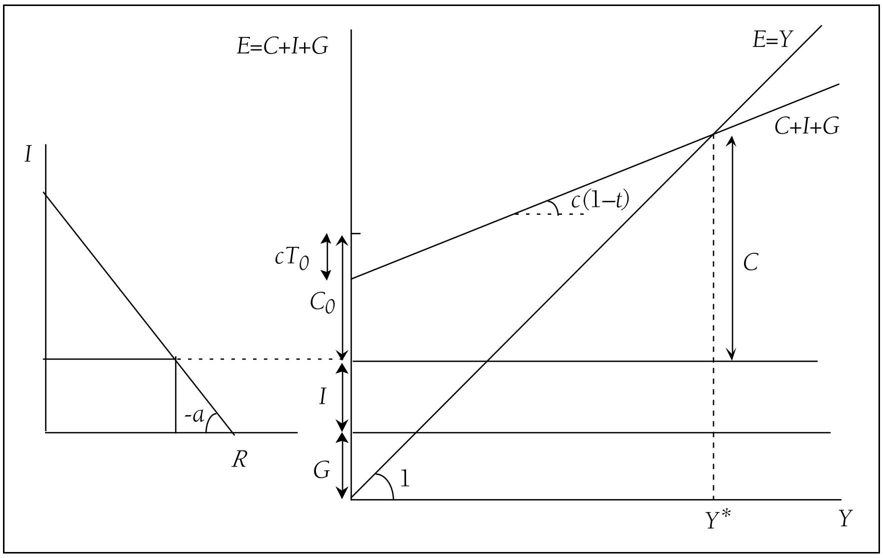


Figure 2.2 The "Keynesian cross" diagram

Note that the axes of the diagram on the right represent the two endogenous variables, C and Y of the flowgraph of Figure 2.1(b), and that the slopes of the two lines in the Keynesian cross diagram are given by the arc transmittances $C \rightarrow Y$ and $Y \rightarrow C$ of that flowgraph.

Now conduct the following thought experiment. Suppose that the real interest rate R is reduced by one unit (one percentage point, say), and examine the consequences for the equilibrium level of output Y^*. The $C+I+G$ line shifts upward by the induced change in investment, a. It now crosses the $E=Y$ line further to the right. But how much further? It is not easy to see from the diagram, which only gives us a qualitative answer (Y^* increases). But the transmittance calculation from the flowgraph does give the result, as $a/(1-c(1-t))$, which could also be obtained from the equations by algebra. It turns out that this is a key transmittance in the larger IS-LM system to be derived below: it is the absolute value of the slope of the IS curve in R-Y space. To emphasize this, Figure 2.3 shows the reduced form of the IS flowgraph with only Y and exogenous variables as nodes, juxtaposed with the IS curve.

The reduced form flowgraph of Figure 2.3 shows how GDP is determined by the exogenous variables in the IS system. In particular we see that changes in R induce changes in Y with transmittance $-a/(1-c(1-t))$. Y varies inversely with R, and the covariation of Y and R traces out the IS curve on the right in Figure 2.3. Changes in government spending and taxes produce horizontal shifts in the IS curve.

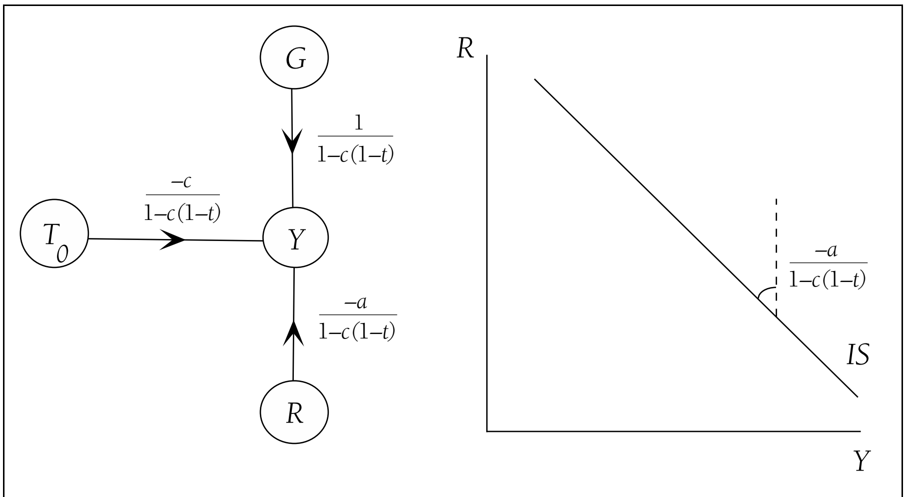


Figure 2.3 The IS curve

Exercise 1

In the IS model of section 2.1, replace the linear tax function with a simple lump-sum tax: $T = \overline{T}$. Redraw the flowgraph and evaluate the transmittances from exogenous variables to the endogenous variables. Condense the flowgraph to display just *C, G, R, T* and *Y*.

2.2 Dynamics in the IS model

The model of Section 2.1 is of an equilibrium system. However any explanation of what happens when an exogenous variable changes is bound to involve dynamics. For example, an unplanned change in stocks (inventories), persuades producers to reduce output if stocks increase or to increase output if stocks fall. It is not difficult to bring stocks or inventories explicitly into the model, but for simplicity we merely replace the equilibrium condition, equation (2), with the following simple dynamic adjustment equation:

$$Y = \mathrm{L}E\ ,$$

which says that output is equal to expenditure in the previous period.

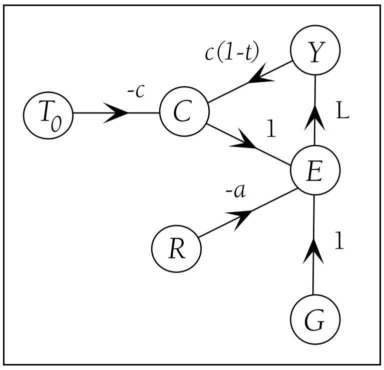


Figure 2.4 IS model with simple dynamics

The system determinant is $\Delta = 1 - \mathrm{L}c(1-t)$. Using Mason's rule we derive the transmittances implied by the model, for example the transmittance from autonomous taxes to GDP:

$$\left\langle \frac{Y}{T_0} \right\rangle = \frac{-c\mathrm{L}}{1-\mathrm{L}c(1-t)} \xrightarrow{\mathrm{L}=0} 0 \quad \text{in the short-run, and}$$

$$\xrightarrow{\mathrm{L}=1} \frac{-c}{1-c(1-t)} \quad \text{in the long-run.}$$

The long-run corresponds to "equilibrium", and we see that this agrees with the result of Section 2.1.

> **Exercise 2**
> Find all the long- and short-run transmittances from T_0, G and R to C, E and Y.

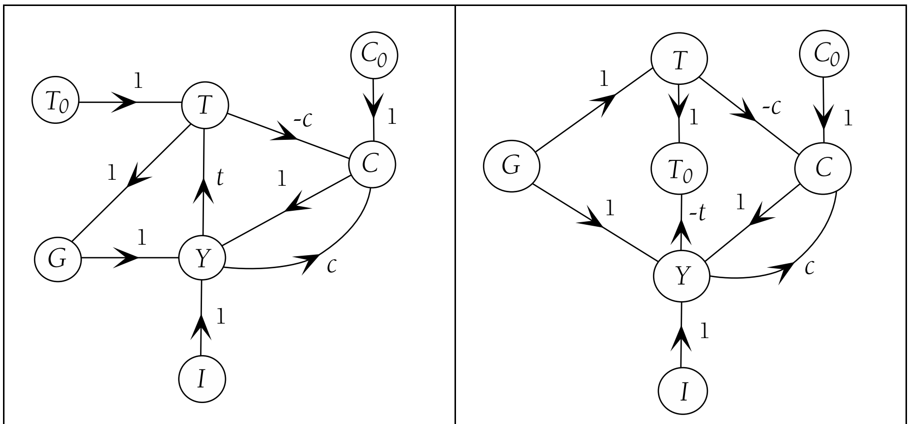
2.3 Short-run IS model with a balanced budget

In the absence of a monetary or financial sector the government is unable to escape from the need to balance its budget. The obligation to match public spending with tax receipts is known as the government's budget constraint. It has the effect of changing the topography of the flowgraph of the model by introducing a connection between taxes and government spending. But how they are connected depends on the *manner* in which the budget is balanced. There are several ways in which a balanced budget can be achieved. The government could balance its budget by adjusting the fixed element of taxes, or by changing the marginal tax rate t, or by adjusting the level of government spending. The connections in the flowgraph and the behaviour of the model depend upon which of these means is used to achieve budgetary balance. Here we examine two scenarios: (a) the government treats T_0 as fixed and adjusts G to balance the budget, and (b) the government treats G as fixed and adjusts T_0 to balance the budget.

We keep the same equations as those of the model of section 2.1 except that the interest rate is omitted for simplicity and an equation for the balanced budget is introduced:

$Y = C + I + G$	income equals expenditure;
$C = C_0 + c(Y\text{-}T)$	consumption function;
$T = T_0 + tY$	tax function;
$G = T$	balanced budget.

These equations give rise to different flowgraphs depending on which variables are assumed to be exogenous.



a. Government sets T_0 and adjusts G to get a balanced budget

b. Government sets G and adjusts T_0 to get a balanced budget

Figure 2.5 Balanced budget models

Note that the flowgraph on the left has three loops, while that on the right has just one. This affects the "system determinant"—*i.e.* the denominator in the formula of Mason's rule. Another important difference between these flowgraphs is the set of paths between variables. Note that on the left there is just one path from G to Y, whereas on the right there are two.

Exogenous variables.	Endogenous variables dY	dT	dC
dI	$\frac{1}{(1-c)(1-t)}$	$\frac{t}{(1-c)(1-t)}$	$\frac{c}{(1-c)}$
dC_0	$\frac{1}{(1-c)(1-t)}$	$\frac{t}{(1-c)(1-t)}$	$\frac{1}{(1-c)}$
dT_0	$\frac{1}{(1-t)}$	$\frac{1}{(1-t)}$	0

Table 2.1 Multipliers (transmittances) in Model (a)

Exogenous variables.	Endogenous variables dY	dT	dC
dI	$\frac{1}{(1-c)}$	0	$\frac{c}{(1-c)}$
dC_0	$\frac{1}{(1-c)}$	0	$\frac{1}{(1-c)}$
dG	1	1	0

Table 2.2 Multipliers (transmittances) in Model (b)

Several interesting comparisons can be made. Firstly, note that the transmittances ("multipliers") are quite different from those of the model of Section 2.1. Secondly, by comparing Table 2.1 and 2.2, it can be seen that the "GDP multipliers" from shocks to investment and consumption are affected by the manner in which the government balances its budget. Model (a) generally has the larger multipliers, however the consumption multipliers are not affected by the budget balancing scheme. Thirdly, the tables confirm that Haavelmo's celebrated balanced budget result—that

GDP and government spending change by equal amounts—holds irrespective of how the budget balance is brought about (recall that dT=dG in these models). To see this in model (a) where both T and G are endogenous, note that dY=dT (=dG) when T_0 changes.

With the help of the flowgraph, let us consider why consumption is quite insensitive to changes in taxes and government spending in these balanced budget models. In Model (a) there are two paths from T_0 to C, with equal and offsetting transmittances. An increase in autonomous taxes raises total taxes, thereby depressing disposable income, but the increase in total taxes also raises government spending, and thereby GDP by an equal amount, so there is no net effect on disposable income. Hence consumption cannot change. A similar story can be told for Model (b), beginning with a change in government spending.

Exercise 3

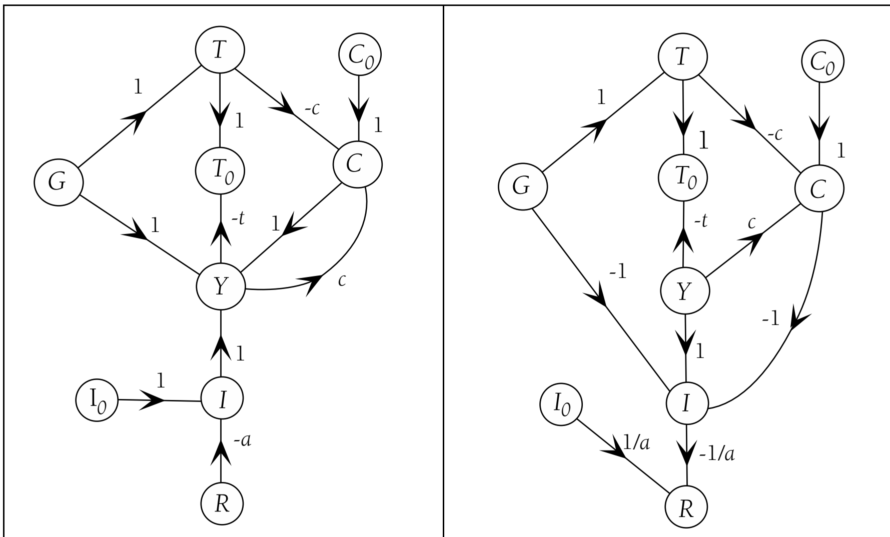
i. How does a balanced budget affect the slope of the IS curve?

ii. Add an equation for government spending, $G = G_0 + gY$ to the model of this section and modify Figure 2.5b to create a flow graph in which I, C_0 and G_0 are exogenous. Construct a table of multipliers for this model and compare them with those of the model of Fig. 2.5b.

2.4 Long-run IS model

What should be understood by the terms "long-run" and "short-run" depends upon the context. Often the term "long-run" refers to the steady-state equilibrium of a dynamic system, while in a different context, usually microeconomic, the term could refer to a state in which all factors of production are variable. In the present context the long-run is a state in which output is at full capacity, constrained by the given factor inputs, so it applies to the trend state of the classical macroeconomy, abstracting from the business cycle. Thus output and expenditure are pinned down, exogenous. But equilibrium in the IS model still implies that output equals intended expenditure (or intended savings equals intended investment), though this cannot now be brought about by variations in aggregate demand; instead it is brought about by adjustment of the real interest rate.

Figure 2.6(a) is essentially the same as Figure 2.5(b), but with a couple of extra nodes to give a bit more detail. It represents the Keynesian "short-run" in which total expenditure adjusts to bring about equilibrium in the system. By contrast, although Figure 2.6(b) represents the same equations, it displays a flowgraph with causality reversed between GDP and the real interest rate.



a. Short-run: *R* exogenous and *Y* endogenous

b. Long-run: *Y* exogenous and *R* endogenous

Figure 2.6 Causality reversal in the IS model

The long-run interpretation of the IS model is in effect a version of the classical loanable funds theory. With total output (and expenditure) given, an increase in government consumption *G* or in private consumption C_0 must reduce savings, and also investment. The interest rate has to rise in order to bring investment down to this lower level of savings. Also, with a given level of savings, a rise in autonomous investment I_0 pushes up the real interest rate. Thus, with total output exogenous, a rise in any of the components of aggregate demand increases the interest rate. But an increase in output, although it must raise private consumption and investment, will push the real interest rate down.

Exercise 4

i. Ascertain for yourself that the two flowgraphs of Figure 2.6 imply the same equations. Also, check that the flowgraph procedure for causality reversal enables 2.6(b) to be derived from 2.6(a).
ii. Give an explanation of the long-run IS model in terms of a traditional "supply and demand" type of diagram, with the interest rate on the vertical axis and savings and investment on the horizontal axis.
iii. Suppose that the consumption function depends on the rate of interest, $C = c(Y–T) – bR$. How does this affect the short-run sensitivity of Y to changes in G in the model of Figure 2.6(a)? How does it affect the long-run sensitivity of R to changes in G in the model of Figure 2.6(b)?