12 An Introduction to Aggregate Demand

The central question of macroeconomics is what determines the level and growth rate of GDP. In chapters 6-9 looked at the economy from the side of aggregate supply. How did the producers decide how much to produce? And how did they decide how many workers and how much capital to employ in the process. Of course, producers can profit only if they are able to sell their output. So in this and the next three chapters, we look at the economy from the side of aggregate demand. How do people decide how much to spend?

12.1 A Simple Model of Aggregate Demand

The national income and product accounts (see Chapters 2 and 3) provide a good starting point. The accounts must always balance; the four national-income-accounting identities (equations (2.1)-(2.4)) must always hold *ex post* or in people's plans. Macroeconomic equilibrium occurs when they also hold *ex ante*: everyone's plans are simultaneously fulfilled.

Think back to Chapter 2. The product-expenditure identity (equation 2.1'') is rewritten here as:

(12.1) $$Y \equiv C + I + G + NX.$$

We can think of Y in the equation as the level of aggregate demand. Our focus will be to explain the different elements on the right-hand side. In this chapter, we take the bird's-eye view: How do spending plans of the different households, firms, the government, and the foreign sector become coordinated? That is, how does the economy reach equilibrium – if it in fact does reach equilibrium? What determines the actual values of GDP and other aggregates in equilibrium? And how does the economy behave away from equilibrium? In order to keep sight of the big picture, this chapter focuses on the question, how to the different elements of aggregate demand interact to determine the total? In later chapters, we examine each of the different elements in more detail.

12.1.1 Consumption Behavior

Consumption is the largest component of aggregate expenditure (see Figure 2.6 and Problem 2.1). We can make a start at understanding aggregate demand by understanding consumption.

The Consumption Function

Many factors determine how much people consume. (We consider consumption in detail in Chapter 14.) One factor stands out above all the others: typically, people consume more if they have more income. In his *General Theory of Employment, Interest and Money* (1936), John Maynard Keynes famously put it this way:[1]

> The fundamental psychological law, upon which we are entitled to depend with great confidence both *a priori* from our knowledge of human nature and from the detailed facts of experience, is that men are disposed, as a rule and on the average,

[1] Keynes (1883-1946) is by most reckoning the most influential economist of the 20th century. (His surname rhymes with "trains" not with "beans.")

> to increase their consumption, as their income increases, but not by as much as the increase in their income" (p. 96).

This means that if you receive an additional dollar of income, you will increase your expenditure, but by less than one dollar. The amount that you increase your expenditure is known as the **MARGINAL PROPENSITY TO CONSUME** (or **mpc**) and is defined as *the rate at which consumption increases when (disposable) income is increased by a small increment*.

The mathematical relationship between consumption and the factors that determine it is known as the **CONSUMPTION FUNCTION**. A simple linear consumption function captures Keynes's point:

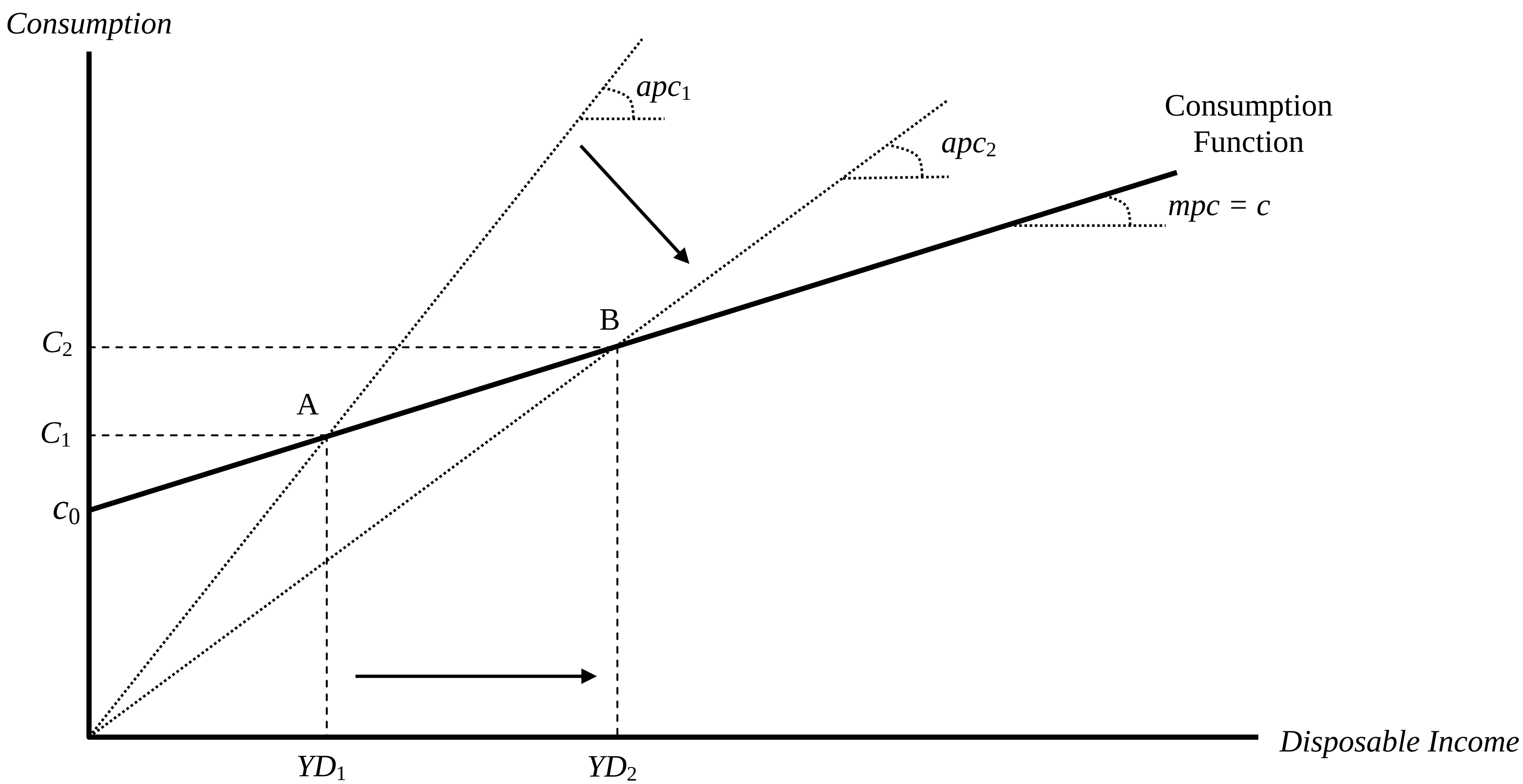
$$C = c_0 + cYD. \tag{12.2}$$

C is, of course, consumption; YD is disposable income; and c_0 and c are parameters that must be determined from data. Figure 12.1 is a graph of this function. Its slope is the marginal propensity to consume: $\Delta C/\Delta Y = c$ (or, using derivatives, $dC/dY = c$). Keynes's fundamental psychological law can be restated: $0 < c < 1$ – the marginal propensity to consume is positive and lies between zero and one.

The Shape of the Consumption Function

The marginal propensity to consume tells us how much is consumed out of the "last dollar" received. But it does not tell us how much is consumed on average. The

Figure 12.1
The Consumption Function



The consumption function shows the relationship between disposable income and consumption. The slope of the consumption function is the marginal propensity to consume (mpc) – the amount of additional consumption that results from a small increase in disposable income. The average propensity to consume (apc) is the ratio of total consumption to total disposable income, shown by the slope of a ray from the origin to the consumption point.. When disposable income increases from YD_1 *to* YD_2*, consumption rises from* C_1 to C_2*. The mpc remains constant, but the apc falls from* apc_1 to apc_2.

AVERAGE PROPENSITY TO CONSUME (**apc**) is given by C/YD where the marginal propensity to consume is given by $\Delta C/\Delta Y$ or dC/dY. Figure 12.1 shows that a disposable income YD_1 results in consumption C_1 at point A on the consumption function. A ray from the origin to point A has the slope C_1/YD_1. In other words, the slope of a ray from the origin measures the *apc*.

The ray to point A is steeper than the consumption function itself. This reflects a general property:

- *the average propensity to consume is greater than or equal to the marginal propensity to consume (*apc $\geq$ mpc*).*

When the consumption function is linear (as in Figure 12.1), the marginal propensity to consume is constant, since the slope of the consumption function is constant. But the average propensity to consume is not constant. To illustrate, look what happens if disposable income increases to YD_2? The marginal propensity to consume at point B is just the same as at point A; but the average propensity has fallen from apc_1 to apc_2.

The property that the average propensity to consume falls with increasing disposable income tells us something about the shape of the actual consumption function. Consider the function:

(12.3) $$C = c_0 + cYD = 135.8 + 0.8YD.$$

The values of c and c_0 are chosen to make the function fit the1948 data exactly: C_{48} = \$1,054.4 billion and YD_{48} = \$1,148.2 billion. The average propensity to consume in 1948 is $apc_{48} = \frac{1{,}054.4}{1{,}148.2} = 0.92$. Now suppose that we believe that the same consumption function should describe 2003. Disposable income in 2003 was $7,801.1 billion. Equation (2.3) predicts that C_{03} = 135.8 + 0.8(7,801.1) = $6,376.7 billion and *predicted* $apc_{03} = \frac{6{,}376.7}{7{,}801.1} = 0.82$. Just as we expected, it predicts that the average propensity to consume should fall markedly over 55 years.

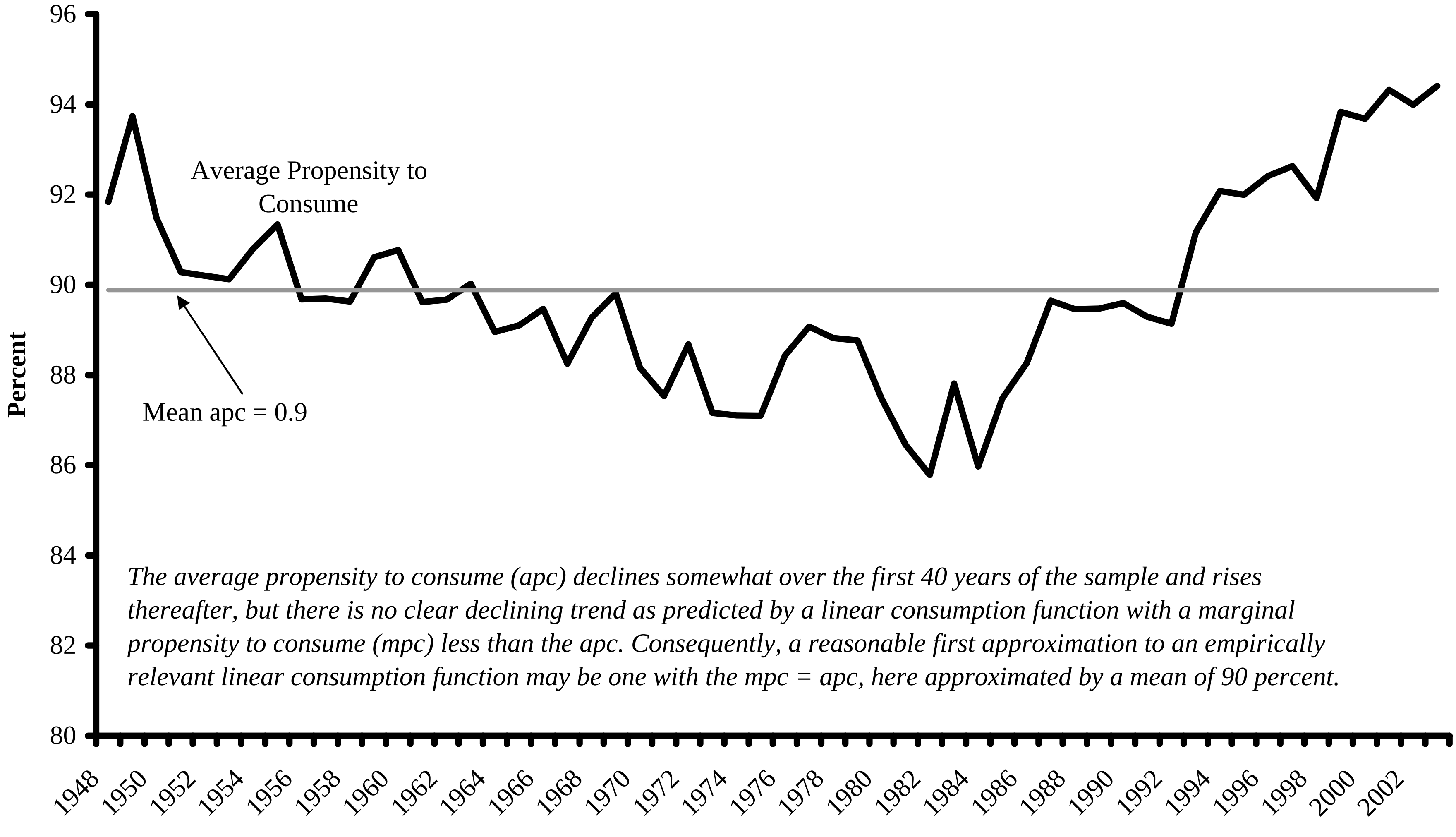
But what actually happened? Actual consumption in 2003 was C_{03} = $7,365.2 billion, so that the *actual* $apc_{03} = \frac{7{,}365.2}{7{,}801.1} = 0.94$ – a little bit higher than in 1948. In fact, Figure 12.2 shows that the average propensity to consume for the United States fell until around 1980 and then rose (with some ups and downs) after that. But there is no consistent, long-term downward trend.

The behavior of the actual average propensity to consume is hard to reconcile in detail with the simple linear consumption function. We will put off discussion of more complicated functions until Chapter 14. Meanwhile, we approximate the *apc* by its average level: 0.90. Is there a linear consumption function that holds the *apc* constant at that level?

Yes. Notice that if $c_0 = 0$, then the consumption function goes through the origin in Figure 12.1. Since every ray from the origin would then lie along the consumption function itself, the *apc* would be constant and would have the same value as the *mpc*. So for the U.S. data, we can approximate the consumption function as:

(12.4) $$C = 0.90YD.$$

Figure 12.2
The Average Propensity to Consume for the United States



Source: Bureau of Economic Analysis and author's calculations.

The Savings Function

Sometimes it is helpful to think in terms of what is not consumed, *savings* (S), rather than in terms of consumption (C). The two notions are connected through the disposable-income identity (equation (2.2)) – repeated here as

(12.5) $$YD \equiv Y - T + TR \equiv C + S,$$

which states that disposable income is divided between consumption and saving.

Substituting equation (12.2) into (12.5) and rearranging gives us the **savings function**:

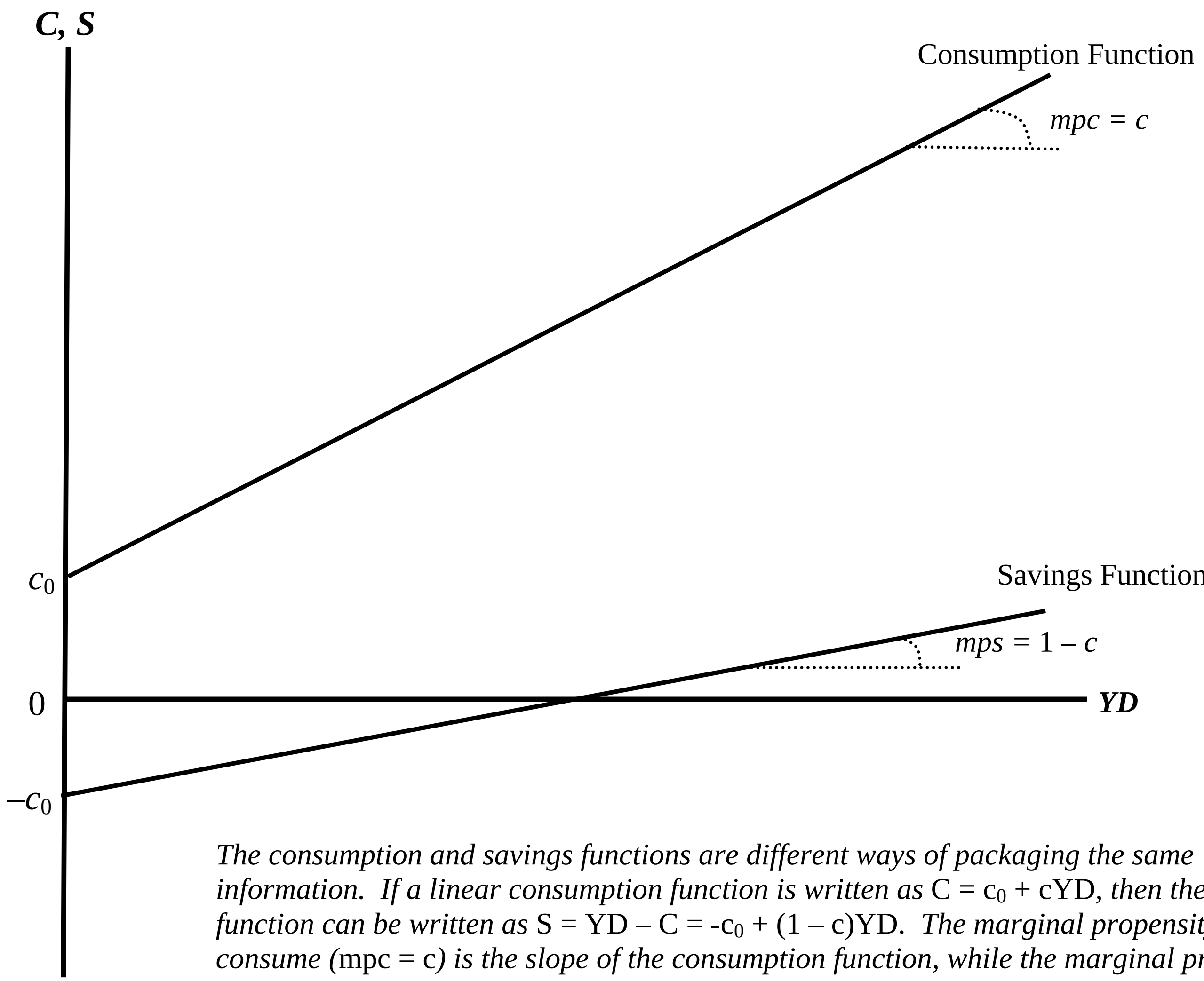
(12.6) $$S = YD - (c_0 + cYD) = -c_0 + (1 - c)YD.$$

The savings function and the consumption function describe exactly the same behavior from different perspectives.

Both functions are graphed in Figure 12.3. Both are straight lines. The slope of the consumption function is $mpc = c$. The slope of the savings function is $1 - c$. This slope measures the **marginal propensity to save** (**mps**) defined as *the rate at which savings increases when (disposable) income is increased by a small increment*.

Notice that $mps = (1 - mpc)$ or, equivalently, that $mpc + mps = 1$. This says that, if you receive an extra dollar, part goes to consumption and the remainder goes to saving.

Figure 12.3
Linear Consumption and Savings Functions



The consumption and savings functions are different ways of packaging the same information. If a linear consumption function is written as $C = c_0 + cYD$*, then the savings function can be written as* $S = YD – C = -c_0 + (1 – c)YD$*. The marginal propensity to consume (*$mpc = c$*) is the slope of the consumption function, while the marginal propensity to save(* $mps = 1 – c$*) is the slope of the savings function* ; *and* $mpc + mps = 1$.

For example, suppose that *mpc* = 0.92, then *mps* = 1 – 0.92 = 0.08. If you receive an extra dollar, 92¢ goes to consumption and 8¢ goes to savings.

If equation (12.4) were a good first approximation of a consumption function for the United States, the a savings function can also be approximated by setting $c_0 = 0$ and $c = 0.90$ in equation (12.6):

(12.7) $$S = 0.11YD.$$

12.1.2 Tax Behavior

Net Taxes

Consumption and savings depend on disposable income; disposable income depends on GDP, taxes, and transfers. The disposable-income identity (equation (12.5)) can be rearranged:

(12.8) $$T - TR \equiv Y - C - S.$$

It is convenient to treat transfer payments as *negative taxes* and to drop *TR* as an explicit variable, so that equation (12.8) can be rewritten as:

(12.8’) $$T \equiv Y - C - S.$$

Taxes (*T*) cover every kind of deduction (explicit taxes) or contribution (transfer payments) from every level of government – federal, state, and local – from GDP. The variable *T* represents not just personal taxes but taxes of every kind – any net flow of funds to the government that opens a gap between GDP, the ultimate source of income, and consumption and saving. (Saving here is not just personal saving, but saving of firms and governments as well – see Chapter 3, section 3.7.)

The government does not levy taxes simply by making up tax bills and sending them to citizens. Mr. Fernandez does not receive a bill from the Internal Revenue Service saying "please pay $15,000" nor does Ms. Chung receive a bill saying "please pay $8,980" independent of any action they have themselves taken. Instead, taxes depend on our economic choices – the amount we earn (income taxes), the amount we spend in general (sales taxes), the amount we spend on particular things such as gasoline or cigarettes (excise taxes) – or on our economic fortunes (inheritance taxes). The government sets the rates, not the actual levels of the revenues that they generate. The top rate of Federal income tax in 2001 was, for example, 35 percent. How much revenue this rate generates depends on how much taxable income people earn.

Transfer payments also depend to some degree on people's incomes. Roughly three-quarters of the Federal budget goes to transfer payments: Federal pensions, Social Security, Medicare, Medicaid, assorted welfare programs, and interest on the Federal debt. State and local governments also spend considerable amounts on transfers. Some of these payments depend only on unchangeable facts about the recipient – for example, having retired from the Federal government. Others depend on the state of the economy.

When times are good and GDP is relatively high, welfare payments fall. Transfer payments would, then, appear to vary inversely with the state of the economy.

Yet not all transfer payments act the same way. Interest payments are more complex. When times are good, interest rates tend to rise, which would raise the governments' interest payments. On the other hand, when times are good, governments tend to run surpluses, which are used to pay off part of their debt, lowering interest payments.

On balance, transfer payments are probably countercyclical – rising in bad times and falling in good times – acting to offset explicit taxes so that the rate of net taxation is lower.

The Tax Function

The Federal tax code is tremendously complex, involving many different rates for corporations and individuals, at different levels of income and for different family structures, different exemptions, as well as many different indirect taxes. And, of course, each state and locality adds its own complicated tax code. It would be impossible to capture all the detail in a model that we could easily grasp.

Fortunately, for our purposes a simple linear **tax function** will be a good enough approximation:

$$T = t_0 + tY. \quad (12.9)$$

Here t is the **marginal tax rate** – a number between 0 and 1 that expresses the fraction of an additional dollar of income goes to taxes. The intercept, t_0, is probably negative, since income taxes generally start only after a certain threshold level of income is reached and some forms of transfer payments are highest when incomes are lowest. Figure 12.4 graphs the function. Only the portion above the Y axis is relevant, since taxes cannot be negative. An important message of this function is that the level of taxation rises as the economy grows.

Also notice, just as with *apc* and the consumption function, that the slope of a ray from the origin measures the **average tax rate** (T/Y). The function illustrates two general characteristics of the tax function. Since the intercept (t_0) is negative, the slope of a ray from the origin to any point on the tax function is flatter than the function itself:

- *the average rate of taxation is typically lower than the marginal rate of taxation*.

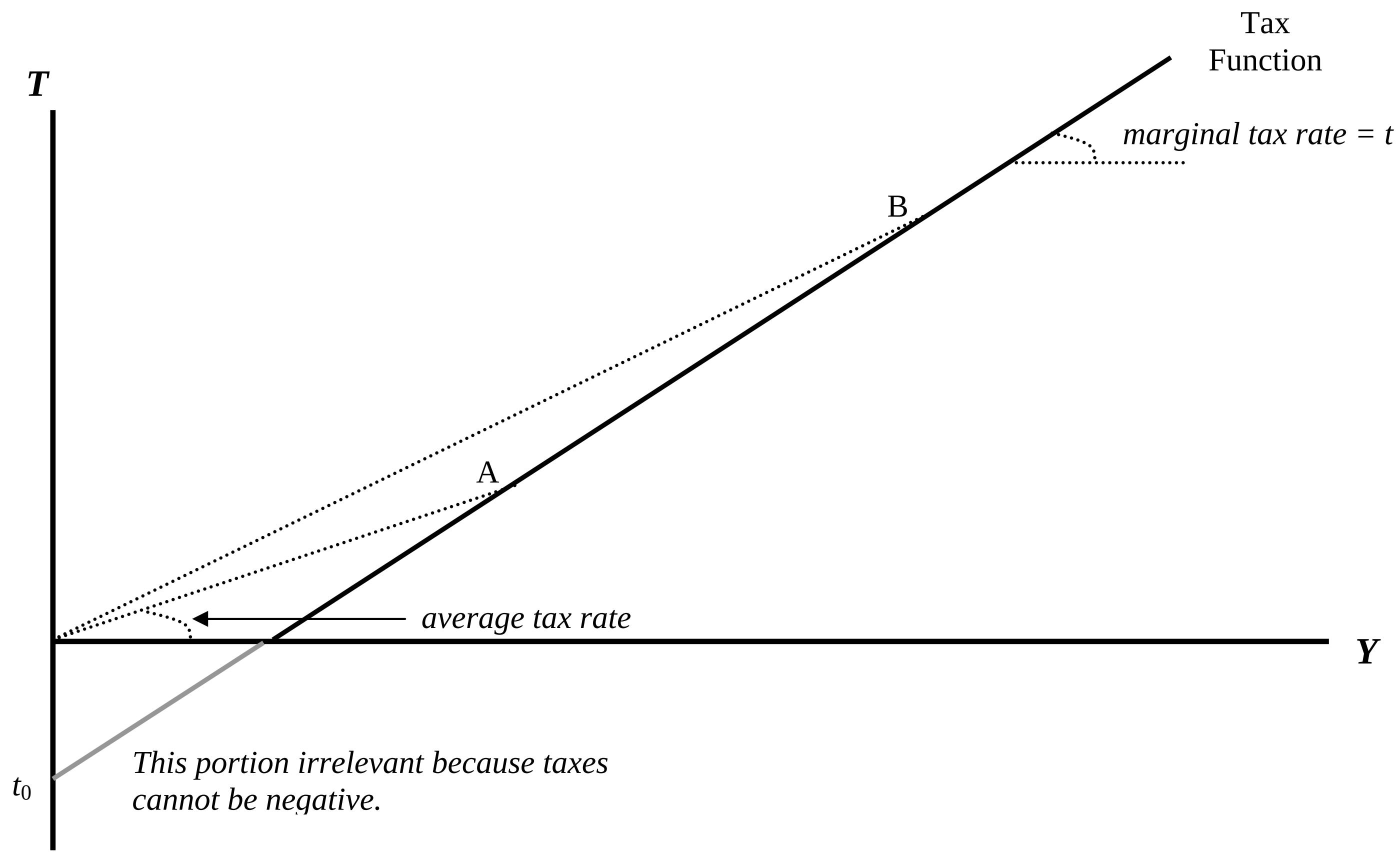
Also notice that the ray to point B is steeper than the ray to point A:

- *the average rate of taxation typically rises with increasing income.*

The Shape of the Tax Function

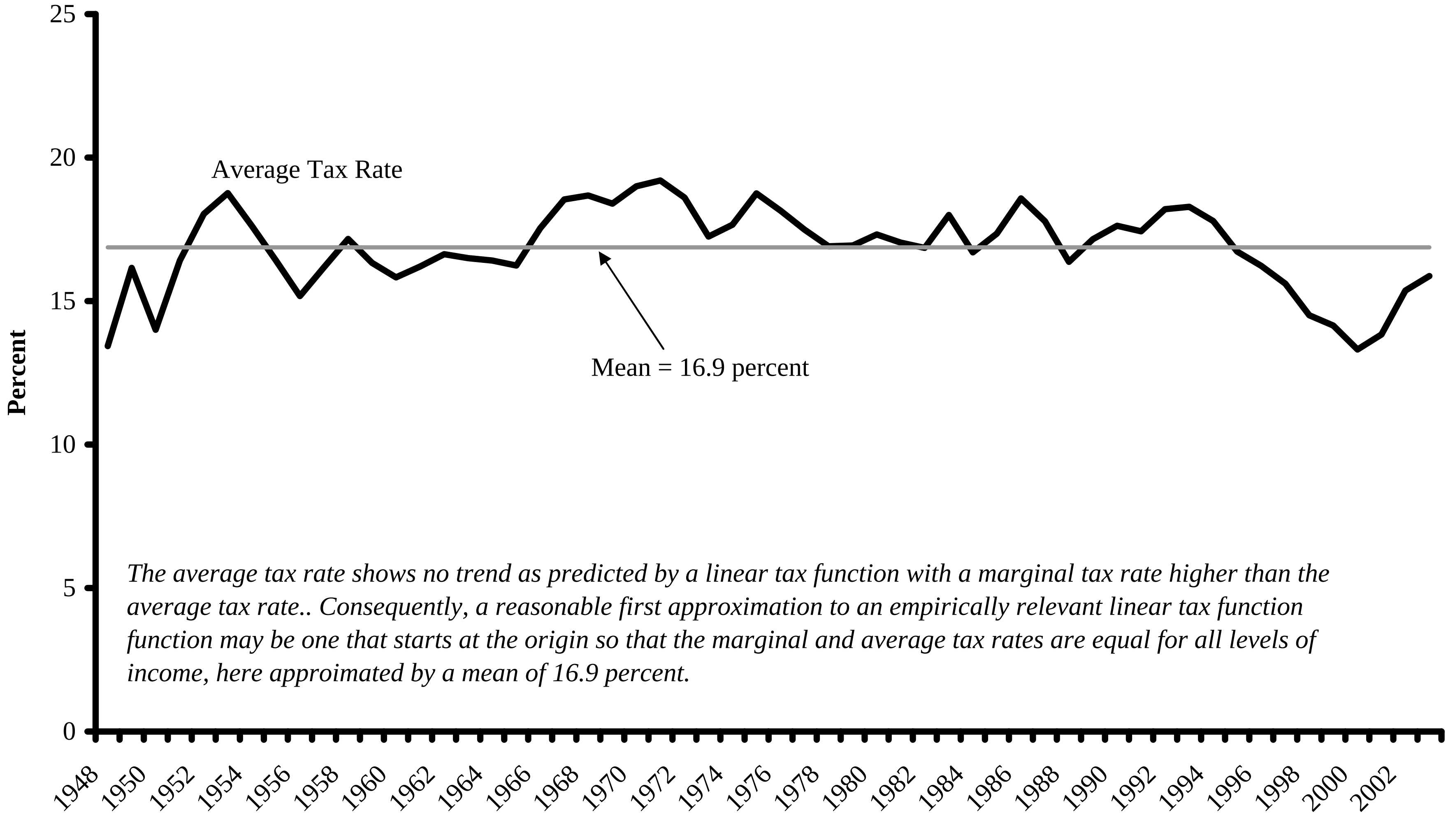
As with the consumption function, we can use data to pin down a good approximation for the tax function. Figure 12.5 plots the average tax rate for the United States. There is considerable variation from year to year, but there is no clear upward trend. As with the consumption function, this would make sense only if the average and marginal tax rates were the same so the tax function goes through the origin. The mean value for the average tax rate in the figure is 17 percent. So setting $t_0 = 0$ and $t = 0.17$, equation (12.9) becomes

12.4
The Tax Function



A linear tax function has a constant slope (marginal tax rate) and may intersect the vertical axis below zero if low income people are not taxed. The average tax rate is given by the slope of a ray from the origin to the tax function. It rises with rising income, unless the function starts at the origin in which case the marginal and average tax rates would be equal.

Figure 12.5
The Average Tax Rate for the United States



Source: Bureau of Economic Analysis and author's calculations.

(12.10) $$T = 0.17Y.$$

Tax and transfer rates have, of course, not been either simple or constant since the end of World War II, but the success of equation (12.10) as a reasonable approximation says that the result of constant and complicated adjustments to the various tax codes and transfer programs have had a simple net effect: to hold net taxes in aggregate to about 17 percent of GDP for many years.

12.1.3 What Determines the Level of Aggregate Demand?

The Model

To answer the question, what determines the level of aggregate demand?, we combine the economic behavior captured in the consumption and tax functions with the national-income accounting identities to form a simple model of aggregate demand.. Macroeconomic equilibrium occurs when the choices of people represented in the two functions make the identities hold *ex ante* as well as *ex post*.

The inflow-outflow identity (equation (2.4)) is repeated here as:

(12.11) $$I + G + EX \equiv S + (T - TR) + IM.$$

If we subtract *IM* (imports) from both sides and treat transfer payments (*TR*) as negative taxes included in *T*, we can rewrite this as:

(12.12) $$I + G + NX \equiv S + T,$$

where $NX \equiv EX - IM$. We then substitute in the savings function (12.6) and the tax function (12.9) to get

(12.13) $$I + G + NX = (1 - c)YD + tY,$$

where for simplicity we have set c_0 and t_0 equal to zero, which is both realistic and will not change any important conclusions (a point addressed in Problem 12.1). Notice that that when we substituted the savings and tax functions into the national-income-accounting identity (12.12) we also replaced the triple-barred identity sign with the double-barred equal sign. This reflects the fact that (12.13) now reflects economic behavior, the *ex ante* plans of consumers, and not just the *ex post* national accounts.

It is helpful to treat the variables on the left-hand side of equation (12.12) as a group, which we shall call **autonomous expenditure**: $A \equiv I + G + NX$. Substituting in this definition, as well as the definition of disposable income ($YD \equiv Y - T$), and the tax function gives us

(12.14) $$A = (1 - c)(Y - tY) + tY = [1 - c(1 - t)]Y.$$

Rearranging terms gives us a simple model of aggregate demand:

(12.15)
$$Y = \frac{1}{1 - c(1-t)} A.$$

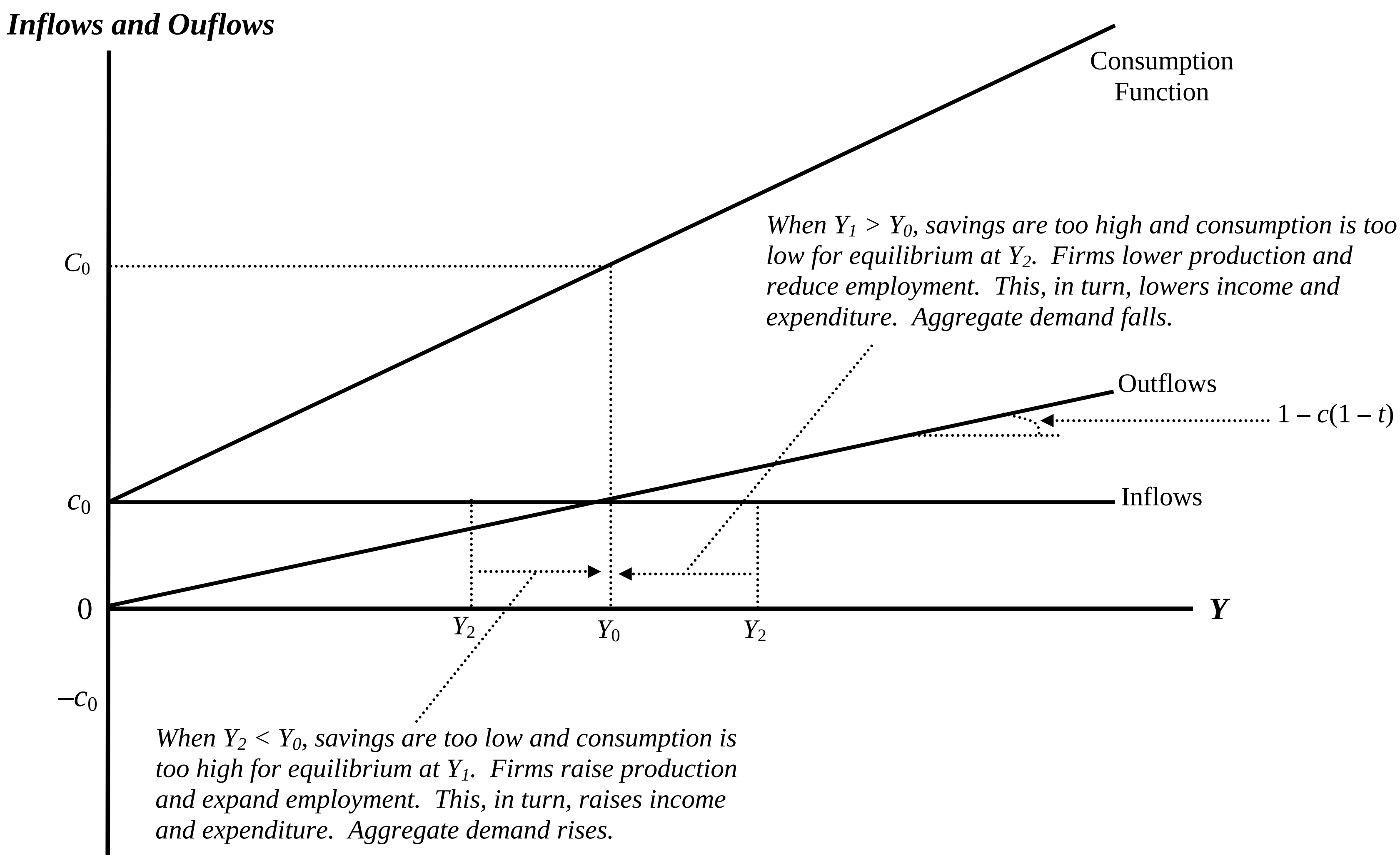
To understand this model, it is helpful to recall the distinction made in Chapter 1 between an **endogenous variable** (*a variable determined within a particular system of the economy or within a model that represents that system*) and an **exogenous variable** (*a variable determined outside that system or model*). In this model, the autonomous variables (*A* and its components *I*, *G*, and *NX*) are exogenous, as are the parameters *c* (the marginal propensity to consume) and *t* (the marginal tax rate). In equation (12.15) only *Y* is endogenous, but the model also includes the consumption, savings, and tax functions, so that *C*, *S*, and *T*, as well as *YD*, are also endogenous.

Equilibrium and Convergence to Equilibrium

There are two natural steps in understanding any economic model. The first is to solve it for its equilibrium values; the second to investigate how those values change when the exogenous variables change. We take a graphical approach to the first step.

Figure 12.6 is based on equation (12.13). We can think of the left-hand side of the equation as representing *inflows* to the domestic private sector, while the right-hand side represents *outflows* – in each case, these interpretations follow naturally from the inflow-outflow identity (equations (2.4) and (12.11)) on which equation (12.13) is ultimately based. Since the inflows are exogenous (and thus not affected by income) in the model, the left-hand side is represented as the horizontal *Inflow curve* at the expenditure level *A*. The right-hand side is represented by the upward-sloping *Outflow*

Figure 12.6
The Determination of Aggregate Demand



curve. Its slope is $1 - c(1 - t)$, which is the coefficient on Y in (12.13). The equilibrium for the model is given at the crossing point of the two lines: Y^*.

The level of aggregate demand, Y^*, is an equilibrium because, at that level of income, the planned savings and taxes generated in the economy (the planned outflows) are exactly enough to balance the planned investment, government expenditure, and net exports (the planned inflows). As a result, Y^* is the level of aggregate demand that coordinates the plans of consumers with those of the other sectors of the economy.

But what happens if aggregate demand is at some other level? Imagine that aggregate demand stood higher than Y^* at Y_1. Savings (adjusting for taxes) would be greater than investment (adjusting for government expenditure and net exports) or, to put it differently, consumers would wish to consume too much for equilibrium at that level of income. (This is the case that we already examined in Chapter 2, section 2.7.) Firms would find themselves with increasing stocks of unsold goods and would lower prices to promote demand and cut back on production to reduce oversupply of their products. For the sake of simplicity, we have assumed for this model, that firms do not adjust prices, so all the adjustment must take the form of reduced production. Reduced production, of course, requires fewer workers, which generates lower incomes, which lowers both savings and consumption. Aggregate demand falls as expenditure falls. So long as income exceeds Y^*, the natural adjustments in the economy push aggregate demand downward toward Y^*.

A similar adjustment takes place when aggregate stands below equilibrium, say, at Y_2. Here investment exceeds savings or, to put it differently, consumers wish to spend more than firms planned to supply. In such a case, firms would find their stocks of inventories falling. If they could raise their prices to choke off demand, they would. They would increase production and, therefore, employment, raising both output and incomes. The increased incomes would increase both savings and consumption expenditures. The additional expenditures increase aggregate demand. So long as income falls short of Y^*, the natural adjustments in the economy push aggregate demand upward toward Y^*.

The Effect of Changes in Autonomous Expenditure on Aggregate Demand

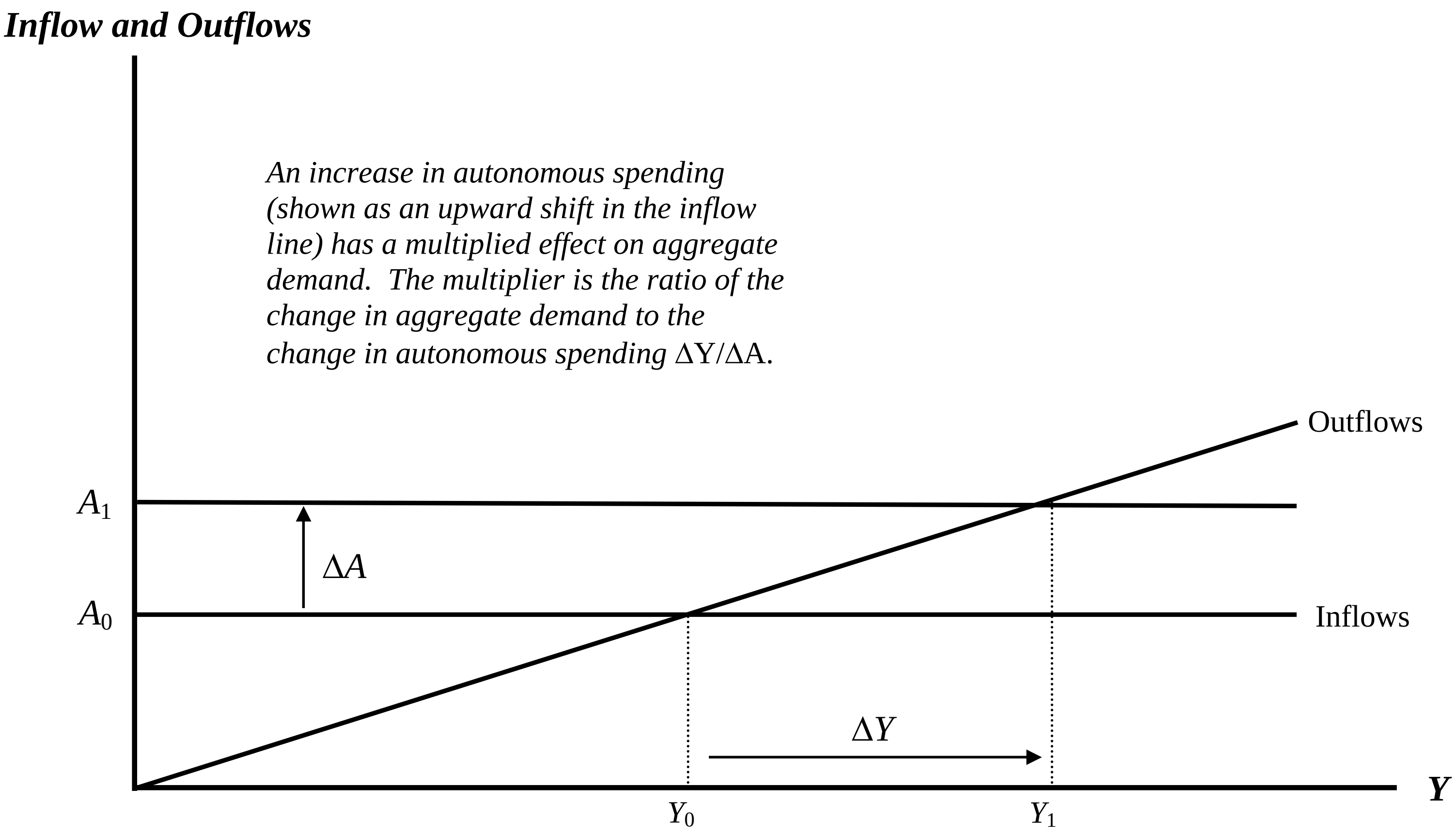
The second step is to ask, what happens when autonomous spending changes? For example, what happens if firms increase their levels of investment by $1 billion? Figure 12.7 shows an increase in autonomous expenditure as the upward shift of the inflow curve from A_0 to A_1. Its point of intersection moves up along the outflow curve, raising equilibrium aggregate demand from Y_0 to Y_1. In general, the same size increase in government expenditure or in net exports would have exactly the same affect on aggregate demand, as each raises autonomous spending by the same amount. And a cut in autonomous spending would reduce aggregate demand.

12.1.4 The Multiplier

The Static Multiplier

When autonomous expenditure rises by $1 billion (or even by $1) how much does aggregate demand rise? To answer that question we need to know the value of the ratio of the increase of GDP (indicated in Figure 12.7 by the horizontal arrow) to the increase

Figure 12.7
An Increase in Autonomous Spending Increases Aggregate Demand



in autonomous expenditure that caused it (indicated by the vertical arrow). This quantity ($\Delta Y/\Delta A$) is known as the **CONSUMPTION MULTIPLIER** (frequently just abbreviated to **multiplier**) and is indicated by μ (the Greek letter "mu"). If $\mu \equiv \Delta Y/\Delta A$, then $\Delta Y = \mu\Delta A$. The trick to answering our question is knowing what value μ takes.

In the real world finding μ may require complex analysis. In our simplified model, it just takes a bit of algebra, which we have already done and reported in equation (12.15). We can rewrite that equation in terms of changes as

(12.16) $$\Delta Y = \frac{1}{1-c(1-t)}\Delta A,$$

so that the multiplier is

(12.17) $$\mu = \frac{\Delta Y}{\Delta A} = \frac{1}{1-c(1-t)}.$$

(We would get the same result for infinitesimal changes by defining the multiplier as $\mu \equiv dY/dA$ and taking the derivative of equation (12.15).)

<u>A Numerical Example</u>

A numerical example may clarify the model and the multiplier formula. Using the average values for the marginal propensity to consume (c = 0.90) and the marginal tax rate (t = 0.17) estimated in sections 12.1.1 and 12.1.2, the multiplier is:

(12.18) $$\mu = \frac{1}{1 - 0.90(1 - 0.17)} = 3.95.$$

An increase in autonomous expenditure of $1 billion would, therefore, yield an increase in aggregate demand of $3.95 billion.

<u>The Size of the Multiplier</u>

What determines the size of the multiplier? Notice that the denominator of the multiplier in equation (12.17) is the slope of the outflow curve in Figure 12.7. The steeper the outflow curve, the smaller the increase in GDP (ΔY) for a given increase in autonomous expenditure (ΔA). The outflow curve will be steeper the larger the denominator in the multiplier formula. The denominator becomes larger when the marginal propensity to consume (c) is smaller or when the marginal tax rate (t) is larger.

Consider some extreme cases:

- If $t = 0$, then $\mu = \frac{1}{1-c}$. For the values in our numerical example $\mu = \frac{1}{1-0.90} = 10$ – that is, more than double its value compared to when $t = 0.17$.
- If $t = 1$ (which says that any additional dollar is completely absorbed in taxes), then $\mu = 1$ – that is, the only effect of an increase in autonomous expenditure is the direct effect. An $1 million increase in government expenditure adds $1 million to aggregate demand, but has no multiplied effect.
- If $c = 0$, then once again $\mu = 1$, and there are only direct, but no multiplied effects.

- If *c* = 1, then $\mu = \frac{1}{t}$. For the values in our numerical example $\mu = \frac{1}{0.17} = 5.88$ – that is, about half again as large as when *c* = 0.90.

These extreme cases illustrate the rules:

- *The multiplier is larger, the higher the marginal propensity to consume*; and
- *The multiplier is smaller, the higher the marginal tax rate.*

<u>The Multiplier Process</u>

The multiplier seems magic. Every time the government increases its expenditure or every time firms sell more products abroad or purchase investment goods, aggregate demand in the economy increases by much more than the initial expenditure. But is it magic?

Not really. The process behind the multiplier is based on one of the oldest ideas in economics: the butcher's purchases become the baker's income, the baker's purchases become the candlestick maker's income, and so on, in a circle coming back around to the butcher.

During the Great Depression of the 1930s, many people suggested that the government should spend more on roads, schools, hospitals, and other public works to "prime the pump." A small increase in government spending on roads would not only give income to the road builders, it would also give income to their landlords, grocers, and clothiers, whose subsequent expenditures would give income to many others.

The English economist A.C. Pigou (1877-1959) was unimpressed by this commonsense idea, and offered a *reductio ad absurdum* argument against it. If this process were effective, Pigou argued, then a single penny's worth of extra expenditure would eventually cascade into greater and greater incomes until, eventually, those incomes would be great enough to purchase the entire output of the economy. But Pigou believed that such an outcome was ridiculous, so the very notion that incomes could be expanded in this manner must be wrong.

Another English economist, Richard Kahn (1905-1989), responded to Pigou in an article written in 1931. Kahn developed a multiplier formula similar to equation (12.17) not to show that the process was powerful, but rather to show that it was not *absurdly* powerful – that it had a limit.

To understand why the multiplier works and why it is not magic after all, it helps to see it as a process. Imagine that the Boeing Aircraft Company purchased $1,000 worth of tools from a specialist supplier. Let's trace out the process through which $1,000 increases aggregate demand.

Assume that anyone who receives income as a result of Boeing's expenditure faces the same tax rate (17 percent) and the same marginal propensity to consume (90 percent). These numbers reflect the average rates used in the multiplier formula (12.18). Anyone who receives income, then, can dispose of only 83 percent (= 100 – 17), so that only 75 percent of the income (= 0.83 × 0.90). On these assumptions what is the effect of Boeing's $1,000 purchase on aggregate demand?

Boeing's initial purchase is a form of investment, and so adds $1,000 directly to aggregate demand. The specialist supplier uses Boeing's payment to purchase inputs and to pay its wages and salaries, profits, and rents. Each of the recipients of this income will, after tax, spend 75 percent. So the initial $1,000 also results in an indirect, second-round expenditure by the recipients of the factor incomes of $750. Now these second round expenditures may be paid for groceries or rent or to make mortgage payments or to buy clothes or any number of other things. Ultimately, they too form the incomes of people. And those people will after tax make third round expenditures of 0.75 × \$750 = \$562.50. The process continues to the fourth round, where consumption expenditures are 0.75 × \$562.50 = \$421.88; and so on for round after round. At each round, additional consumption expenditures become smaller. The process effectively stops when the amount available to spend is less than a penny.

Let's add up the total effects on aggregate demand:

$$\Delta Y = \underbrace{1{,}000.00}_{\textit{direct effects}} + \underbrace{750.00 + 562.50 + 421.88 + \ldots}_{\textit{indirect effects}}$$

This would be easier to analyze if we were specific about the relationships among the different terms. Each is 0.75 times the preceding term, so that

(12.19) $$\Delta Y = \underbrace{1{,}000}_{\textit{direct effects}} + \underbrace{0.75(1{,}000) + 0.75^2(1{,}000) + 0.75^3(1{,}000) + \ldots}_{\textit{indirect effects}}$$

$$= 1{,}000(1 + 0.75 + + 0.75^2 + 0.75^3 + \ldots).$$

To solve this, multiply both sides by 0.75 to yield

(12.20) $$0.75\Delta Y = 1{,}000(0.75 + + 0.75^2 + 0.75^3 + 0.75^4 \ldots).$$

Subtracting equation (12.20) from (12.19) gives us

(12.21) $$(1 - 0.75)\Delta Y = 1{,}000.$$

Each term in parentheses on the right-hand side of (12.19) except for the initial "1" is canceled by one of the terms on the right-hand side of (12.20) all the way out to infinity.

We can solve (12.21) to get

(12.22) $$\Delta Y = \frac{1000}{1 - 0.75} = 4{,}000\,.$$

Boeing's initial purchase results in an increase in aggregate demand of 4 times the initial purchase. Except for rounding in the calculation, this is same multiplier as in (12.18). And in fact, whatever the values for c, t, and ΔA, the sequence in which purchases become incomes become purchases become incomes . . . always results in a total effect given by the multiplier formula (12.17). (Problem 12.2 asks for a general proof of this proposition.)

Looking at the multiplier as the outcome of a sequence of purchases generating incomes reminds us of the importance of the notion of the circular flow of income and expenditures (see Chapter 2, section 2.2.2, and Chapter 3, section 3.1.2 (especially Figure 3.1)). It also makes it clear that the multiplier is not instantaneous, but unfolds over time. The calculation assumes rounds of expenditures. How long a round is depends on how fast the income received is spent. While individual people are paid at various intervals – some daily, more weekly, and probably most biweekly or monthly – they spend constantly. In reality the multiplier traces out an average effect. Each round could on average be as short as a day or, quite reasonably, a week or more. The multiplier process is not quick. If each round expends 75 percent of the round before it, then it takes 26 rounds for the expenditure to fall below one dollar and 42 rounds to fall below one cent. If each round takes a day these correspond to a little more than 3 weeks to reach a dollar and over five weeks to reach one cent. But if each corresponds to a week, then they correspond to 6 and 10 months.

Even though *complete* adjustment takes many rounds, most of the changes occur in the early rounds. Half of the final effect occurs by round 3, three-quarters by round 5, and 90 percent by round 9.

12.2 Fiscal Policy

In Chapter 9 we saw that aggregate demand may be insufficient in some cases to guarantee full employment of labor or to keep the economy operating at its full economic potential. To combat unemployment, the government could try to raise the level of aggregate demand through monetary or fiscal policy. (We will see in Chapter 16 that they may also want to reduce aggregate demand to combat inflation.) We postpone the main discussion of monetary policy until Chapter 17, but the simple model of aggregate demand developed in this chapter gives us the basis for a preliminary discussion of fiscal policy (elaborated in Chapter 18).

Fiscal policy (see Chapter 1) is *the set of actions that determine the levels of government spending and taxes and which together determine the size of the government budget deficit*. **FISCAL POLICY** can be **DISCRETIONARY** (that is, deliberately chosen to achieve a particular result) or **AUTOMATIC** (that is, built into the design of the tax code and spending programs). We first consider discretionary fiscal policy.

12.2.1 Discretionary Fiscal Policy

Choosing the Level of Government Spending

If the government finds the level of aggregate demand to be too low, it can raise it through increasing government spending. This is easily seen as a special case of the scenario described in Figure 12.7. An increase in government spending (G) is just one of many ways that autonomous spending can be raised, and each has a multiplied effect on aggregate demand. But exactly how much should spending be raised?

To guide their fiscal actions, policymakers have built detailed models of the economy. Surprising as it may seem, these complex models (often involving hundreds of equations) are largely constructed according to the same principles that have guided us in this chapter. So even without the hundreds of equations, the simple model and the static multipliers provide a great deal of insight into how economists and policymakers actually design fiscal policies.

An Illustrative Model: Benchmark

Start with a simple, artificial example. Imagine an economy without foreign trade and with taxes, but no transfer payments. Consumers' behavior is described by the consumption function:

(12.23) $$C = 0.8(Y - T).$$

The government levies a simple "flat tax":

(12.24) $$T = (1/6)Y.$$

Initially, government expenditure G = 500, and investment I = 500.

The first question is, what is the equilibrium level of aggregate demand? We solve for it, beginning with the inflow-outflow identity (2.4 or 12.11) with X, M, and TR set to zero:

(12.25) $$I + G = S + T.$$

From equations (12.6) and (12.23), we know that savings $S = (1 – 0.8)(Y – T)$. Substituting this and equation (12.24) into (12.25), as well as the values for I and G gives

(12.26) $$500 + 500 = 1{,}000 = (1 – 0.8)(Y – (1/6)Y) + (1/6)Y = (1/3)Y$$

or

$$Y = 3{,}000.$$

(You should use this value and the tax and consumption functions to check that the national-income-accounting identities hold.)

The *government's budget deficit* is $G + TR - T$. Here, it is *deficit* =500 + 0 – (1/6)3,000 = 0. In words, the budget is balanced.

An Illustrative Model: Case 1

Now, imagine that the government believes – perhaps because there is unemployment – that the level of aggregate demand is too low. It believes that, if it can raise aggregate demand to 3,600, it can eliminate unemployment. How much does it need to increase *G*?

One way to find *G* is to go back to the simple model (for example, in equation (12.26)), replace the 500 that represents government expenditure with the variable *G*, and replace the variable *Y* with the value 3,600, then solve for *G*. Another way is start with the multiplier formula (12.17) with the values $c = 0.8$ and $t = 1/6$ given in the example:

(12.27)
$$\mu = \frac{\Delta Y}{\Delta A} = \frac{1}{1 - c(1-t)} = \frac{1}{1 - 0.8(1-(1/6))} = 3 \,.$$

Since the government wants to raise *Y* from 3,000 to 3,600, $\Delta Y = 600$, and $\Delta A = \Delta Y/\mu = 600/3 = 200$. Any change in autonomous spending of 200 would raise aggregate demand the required amount. The government can achieve its goal by increasing government spending so that $\Delta A = \Delta G = 200$.

The difference between our solution to the government's fiscal planning problem and what actual governments do is that their models are more realistically detailed.

Setting Tax Rates

The government may prefer to stimulate aggregate demand through a tax cut rather than through an increase in government expenditure. As we mentioned in section 12.1.2, governments do not levy taxes in arbitrary amounts; instead they set rates that together with the levels of income or other economic activity determine the total tax take. Taxes are then *endogenous*; while tax rates are *exogenous*. So the question that the government has to answer is: what tax rate is needed to raise aggregate demand to the right level?

The principle is fairly straightforward: lower tax rates raise disposable incomes with a multiplier effect. Figure 12. 8 shows that an decrease in tax rates flattens the outflow curve raising aggregate demand from Y_0 to Y_1. But again, how would the government find the particular tax rate that achieved its goal for aggregate demand?

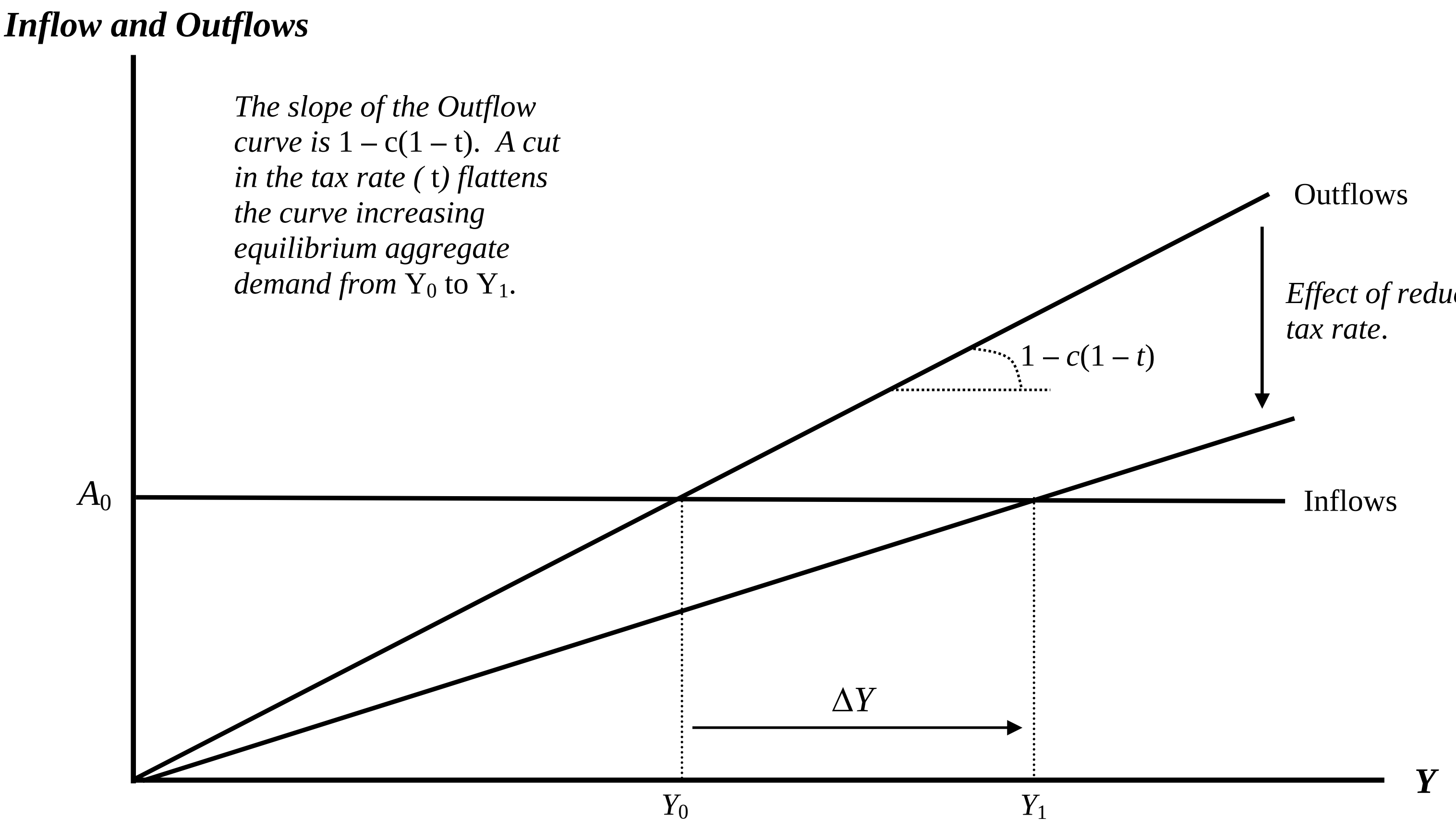
An Illustrative Model: Case 2

One way is to go back to the simple model, replace the tax rate of 1/6 with the variable t and the variable Y with the target level of GDP (3,600), then solve for t. This will give us the same result as using the solution to the simple model given in equation (12.15) with Y = 3,600, c = 0.8, and $A = G + I = 500 + 500 = 1{,}000$:

(12.28) $$3{,}600 = \frac{1}{1 - 0.8(1 - t)} 1{,}000,$$

which can be solved for the tax rate that delivers the desired level of aggregate demand:

Figure 12.8
Cutting the Marginal Tax Rate Increases Aggregate Demand



$$t = 9.72 \text{ percent.}$$

<u>Targeting the Level of Taxes</u>

A politician may believe that the citizens are overtaxed, and coming into office may promise a tax cut of a particular amount – in our model, say, 100. What tax rate would the government have to choose in order to achieve that level of taxation. The problem here is that now the target level of taxes is fixed, while the tax rate must be adjusted to achieve it. The level (T) is now endogenous, while the rate (t) is exogenous. The previous solution to the model (equation (12.15) and the multiplier formula (12.17) assumed just the opposite, so they no longer apply. Instead we must resolve the model under the new assumptions.

We again start with the inflow-outflow identity (12.9 or 2.4), letting autonomous spending $A \equiv I + G + NX$. We substitute in the savings function (12.6), setting $c_0 = 0$ for simplicity, and the definition of disposable income, $YD \equiv Y - T$ (where, as before, we treat transfer payments as negative taxes). This gives us

(12.29) $$A = (1 - c)(Y - T) + T = (1 - c)Y + cT$$

or

(12.29') $$Y = \frac{1}{1-c}A - \frac{c}{1-c}T\ .$$

There are now two consumption multipliers (distinguished by subscripts):

- the **tax multiplier** is *the amount that aggregate demand changes* ceteris paribus (here holding A constant) *for a change in taxes*:

(12.30) $$\mu_T \equiv \frac{\Delta Y}{\Delta T} = -\frac{c}{1-c};$$

- and the **autonomous expenditure multiplier**: is *the amount that aggregate demand changes* ceteris paribus (here holding *T* constant) *for a change in autonomous spending*:

(12.31) $$\mu_A \equiv \frac{\Delta Y}{\Delta A} = \frac{1}{1-c}.$$

The tax multiplier is, of course, negative, since taxes are an outflow from the domestic private sector. But notice that it is also smaller in absolute value than the autonomous expenditure multiplier. If, as in our numerical example, $c = 0.8$, then $\mu_T = -4$ and $\mu_A = 5$. An easy way to see why is to remember that while each of the components of *A* is a direct contributor to GDP *and* has indirect multiplier effects, taxes and transfer payments do not contribute directly to GDP; although, because they change disposable income, they still have multiplier effects. So if we look again at the multiplier process in equation (12.19) and imagine that the stimulus was not $1,000 of additional investment spending, but a $1,000 tax cut or a $1,000 increase in transfer payments, then we would have to drop the first term (the initial $1,000 representing the direct effect) and start with 0.75(1,000), which is of course $c\Delta Y$. Every term then is smaller by the factor *c*; so the tax multiplier itself is smaller in absolute value by the factor *c*.

Also notice that the autonomous expenditure multiplier is larger than the earlier consumption multiplier: $\mu_A = \frac{1}{1-c} > \frac{1}{1-c(1-t)} = \mu$ for all positive tax rates. In fact, μ_A is exactly μ with $t = 0$. That makes sense: when the government targets the level of taxes (T), it makes that level independent of the marginal tax rate; it is as if the marginal tax rate had been set to zero.

An Illustrative Model: Case 3

Now let us return to our problem. What happens in our illustrative model if the government cuts taxes so that $\Delta T = -100$? Using the tax multiplier,

$$\mu_T \equiv \frac{\Delta Y}{\Delta T} = \frac{\Delta Y}{-100} = -\frac{c}{1-c} = -\frac{0.8}{1-0.8} = 4\,.$$

Solving for the change in aggregate demand:

$$\Delta Y = -4 \times -100 = 400.$$

Even though the government has a fixed tax target in this example, it still must implement its target by choosing a tax rate. What rate should it choose? The tax function (12.9) can be solved for the marginal tax rate (setting the intercept $t_0 = 0$):

(12.32) $$t = T/Y.$$

Originally taxes in our illustrative model were 500, but now they have fallen to 400. And originally GDP was 3,000, but now it has risen to 3,400. So the tax rate, which had been 1/6, is now lower at

$$t = T/Y = 400/3{,}400 = 1/9 = 11.11 \text{ percent.}$$

The Balanced-Budget Multiplier

In the benchmark version of the illustrative model, the budget is balanced. What happens to the deficit in *Case 1* in which government spending is increased by 200 to 700, which in turn has a multiplied effect on aggregate demand, increasing it from 3,000 to 3,600? Taxes increase so that $T = tY = (1/6)3600 = 600$. And the deficit then becomes

$$deficit = G - T = 700 - 600 = 100.$$

What if the government found a deficit unacceptable? Could it increase spending and taxes in such a way as to keep the budget balanced *and* increase aggregate demand?

Once again, this is a case in which the level of taxes (T) is exogenous: to keep the budget balanced, it must be that $T = G$, whatever level government spending takes. So the tax rate (t) must be adjusted endogenously to deliver the appropriate level of taxes.

Once again, we go back to the inflow-outflow identity and substitute in the savings function as in equation (12.29). But this time, we use the fact that $T = G$ to eliminate T. It is also helpful to write out the components of A:

(12.33) $$I + G + NX = A = (1 - c)(Y - G) + G = (1 - c)Y + cG$$

or

(12.33') $$Y = \frac{1}{1-c}(I + NX) + G.$$

There is no longer a tax multiplier, since taxes are not a decision variable but are always fixed to be the same as government expenditure. The multipliers for investment and net exports are just the same as the autonomous expenditure multiplier when taxes are exogenous. The extraordinary thing is that an increase in government expenditure increases aggregate demand, but only by exactly the amount that it increases itself. The **BALANCED-BUDGET MULTIPLIER** (that is, *the amount that aggregate demand increases for an increase in government expenditure while adjusting taxes to keep the budget balanced*) is unity:

(12.34) $$\mu_G^{BB} = \frac{\Delta Y}{\Delta G} = 1.$$

One might think that the increase in taxes needed to keep the budget balanced would set up a negative multiplier process that would offset the positive process started by the increase in government expenditure, so that the balanced-budget multiplier was zero. But that is wrong.

There are two processes, each with a separate multiplier. Since the increase in taxes is a fixed amount (exactly equal to the increase in government spending), taxes are exogenous, so equations (12.30) and (12.31) give the appropriate multipliers. The net effect is the sum of the two individual effects:

(12.35) $$\mu_G^{BB} = \mu_A + \mu_T = \frac{1}{1-c} + \left(\frac{-c}{1-c}\right) = \frac{1-c}{1-c} = 1.$$

The offset is not perfect – so the balanced-budget multiplier is not zero – because, as we saw earlier, the tax multiplier is smaller in absolute value than the autonomous expenditure multiplier. The tax multiplier process cancels out the *indirect* multiplier effects of the increase in government expenditure, but leaves the *direct* effect intact.

Illustrative Model: Case 4

Suppose that the government wants to increase aggregate demand by 600 to 3,600, as in *Case 1*, but wants to leave the budget balanced. The fact that the balanced-budget multiplier is unity means that to do so it must raise government spending by just as much as it wants aggregate demand to increase – that is, by 600.

Taxes must also increase by 600 to 1,100. What tax rate must be set to achieve the balanced budget?

$$t = T/Y = 1{,}100/3{,}600 = 30.56 \text{ percent},$$

an extraordinarily steep increase!

12.2.2 AUTOMATIC STABILIZERS

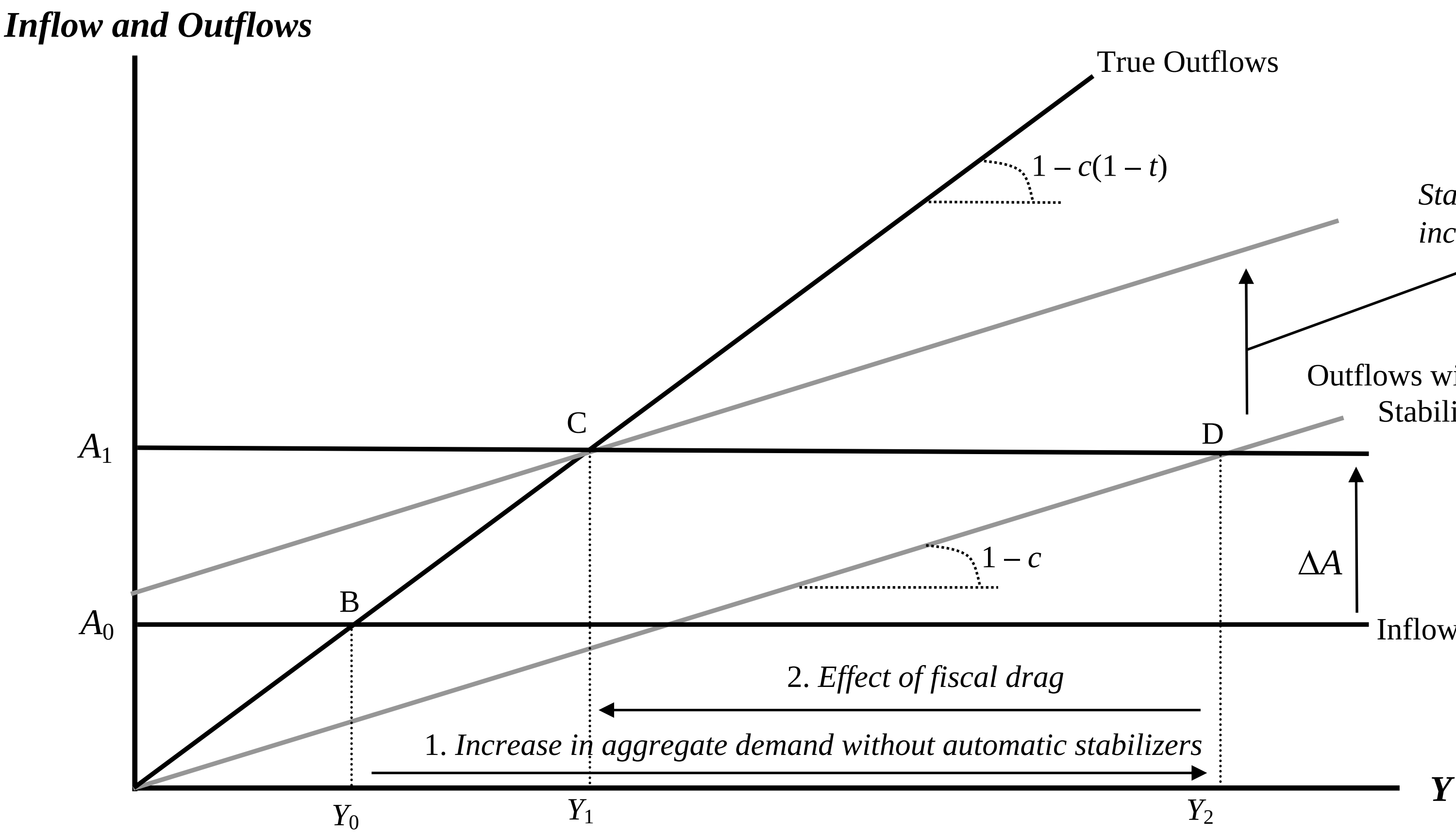
The flows of funds away from production (other than to savings) are sometimes known as **AUTOMATIC STABILIZERS**, because they attenuate the fluctuations in aggregate demand.

Consider the multiplier in equation (12.18): When $c = 0.90$ and $t = 0.17$, $\mu = 3.95$. But when the automatic stabilizer of taxes is removed (i.e., $t = 0$), then $\mu = 10$. Say that firms raised investment by $10 billion. In the first case, aggregate demand would increase by $39.5 billion and, in the second, by $100 billion. Similarly, say that people purchased more foreign goods so that imports increased by $5 billion (a fall in net exports). Then, in the first case, aggregate demand would fall by $19.8 billion and, in the second, by $50.0 billion. Without the automatic stabilizer the fluctuations are more extreme and may give rise to a more immediate need for an offsetting policy action. On the downside, increases in unemployment would be larger, and on the upside increases in inflation would be larger. In all events, GDP would be more variable.

To see why taxes act as an automatic stabilizer, look Figure 12.9. Initially, the economy is in equilibrium at the intersection at point B of the lower inflow curve and the black outflow curve (whose slope is $1 - c(1 - t)$). Aggregate demand is Y_0. Now say that exports increase, which is an increase in autonomous spending, shifting the inflow line upwards and moving the equilibrium to point C, where aggregate demand is Y_1. (The ratio of the change in aggregate demand to the increase in autonomous spending is the multiplier.)

The increase in aggregate demand can be thought of as having two parts. The first is an increase in demand due to the multiplier without any automatic stabilizers. This is indicated by the shallower, gray outflow curve (slope $1 - c$, since no stabilizer

Figure 12.9
The Action of Automatic Stabilizers



The effect of an increase in autonomous spending can be broken down into: 1. *the multiplied increase in aggregate demand that would occur if outflows such as taxes did not increase automatically with increasing income*; *and* 2. *the fiscal drag (or automatic stabilizer) that results from the endogenous increase in taxes.*

means $t = 0$). If this were the true outflow curve, then equilibrium would be at point D and aggregate demand at Y_2. But it is not. The extra aggregate demand generates taxes. These taxes can be thought of as increasing outflows for each level of aggregate demand, shifting the lower gray outflow curve vertically upward by the amount to the new tax generated ($\Delta T = t \times (Y_1 - Y_0)$), so that it intersects the actual equilibrium at point C with aggregate demand of Y_1.

The negative multiplier induced by this tax increase is sometimes referred to as **fiscal drag**. The tax system acts like the tail on a kite, slowing down its movements, but also stabilizing its fluctuations.

It is easy to see how automatic stabilizers got their name. When the economy enters a recession, the government often acts to expand aggregate demand. It may increase government expenditure or transfer payments, cut taxes, or take steps to promote investment. Similarly, when an economy is booming and the government fears that too much demand might promote inflation, it may take the opposite actions to reduce aggregate demand. The automatic stabilizers act in just the same way. As the economy goes into recession, taxes and transfers rise; as it goes into a boom, they fall. It is just as if the policymakers had taken a deliberate action to fight the recession (that is to "stabilize" the economy). While deliberate fiscal policies must be proposed and debated and, once implemented, work through the economy slowly, the automatic stabilizers act immediately without any political or bureaucratic delay.

An element of spending that moves countercyclically acts as an automatic stabilizer. For example, in Chapter 15, we will see that imports typically rise when the economy booms, lowering net exports and so acting as an automatic stabilizer.

12.3 Investment and Aggregate Demand

So far we have examined the role of the consumption and savings decisions of households and the fiscal policies of the government in determining aggregate demand. Next we turn to the investment decisions of firms. (Further analysis of exports and imports is taken up in Chapter 15.)

12.3.1 What Determines the Level of Investment?

The Opportunity Cost of Investment

Investment is the purchase of new capital goods – the physical means of production. Firms invest in order to produce, sell, and make profits. Investment is forward-looking. The costs come immediately, the profits come only sometime later. In this sense, the purchase of an investment good is analogous to the purchase of a bond or other financial asset (see Chapter 10, section 10.2.1). And just as with a financial asset, the choice to invest is a good one when the returns generated using the investment good are higher than the returns that would have been paid on any alternative use of the funds.

The opportunity cost of investment can be measured by the difference between the real returns to an alternative financial asset, such as a bond, and the returns to the investment. We can summarize the real rate of return on investment by the variable ρ – the Greek letter "rho." (We discuss the measurement of ρ in more detail in Chapter 13.) The opportunity cost is then

$$\textit{opportunity cost of holding money} = \textit{real return on the bond} - \textit{real return on investment}$$

$$= rr - \rho.$$

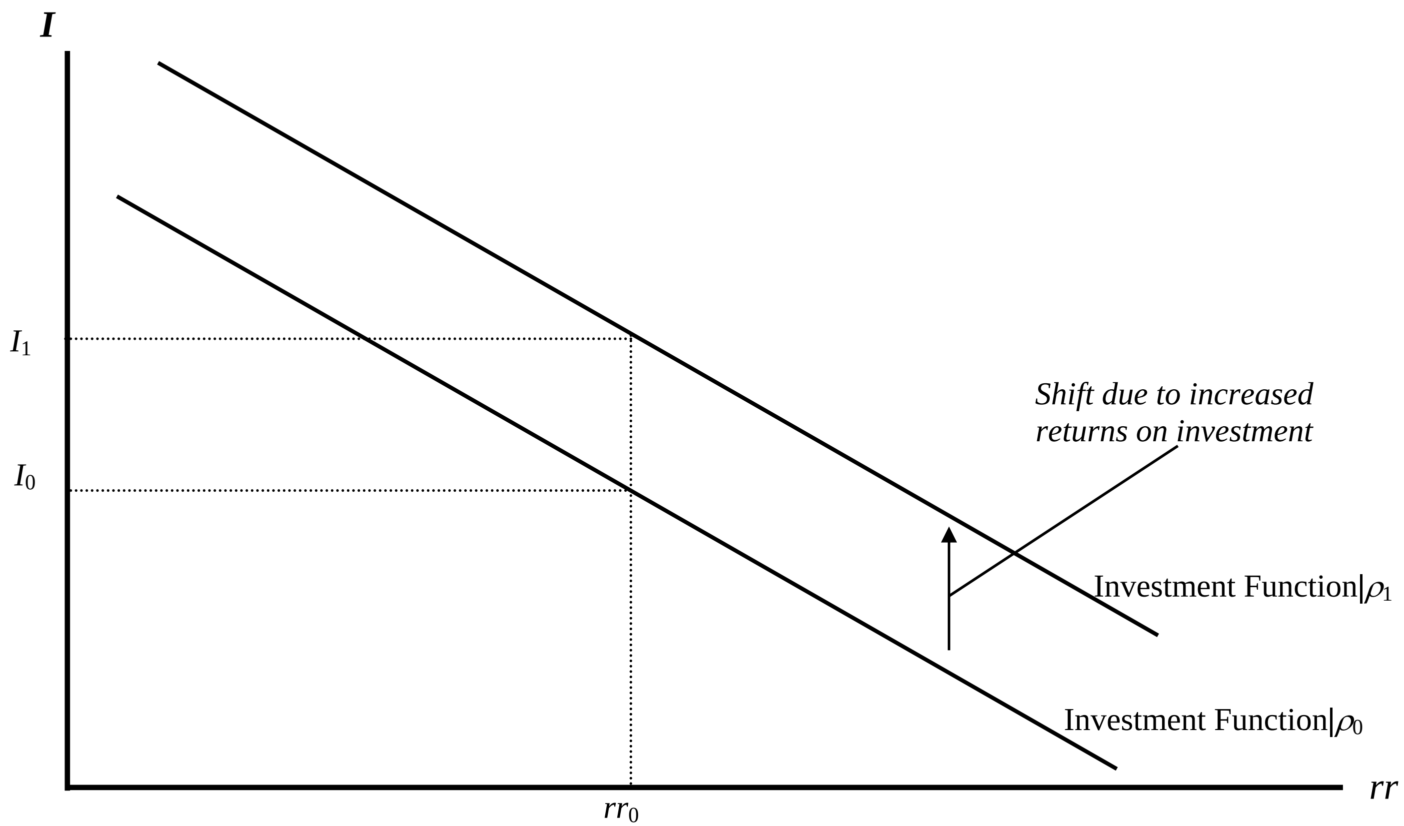
A firm is more likely to prefer to purchase an investment good or engage in an investment project, when this measure of the opportunity cost is low. Different investments will, of course, have different rates of return and, therefore, different opportunity costs. Taking the economy as a whole, for a given rate of return, the higher the real rate of interest, the fewer different investment projects will be expected to generate returns that generate low opportunity costs and the lower the level of investment. Investment expenditure should therefore be inversely related to real interest rates.

Figure 12.10 shows the **INVESTMENT CURVE** (or **FUNCTION**) as a downward-sloping relationship between the real interest rate (*rr*) and real investment (*I*). Because investment also depends on the real returns to investment, the curve must be drawn for a particular level of ρ. The lower curve is drawn for ρ_0 and shows that, when the real rate of interest is rr_0, the level of investment is I_0. If returns to investment rise to ρ_1, then the opportunity cost is lower for each level of the real interest rate, so investment must be higher and the curve must shift upwards. Now at rr_0, investment is higher at I_1.

Investment and Risk

Investment also depends on the risks involved. Compare two projects. One has a guaranteed return of 14 percent per year. The second has a 50 percent chance of earning 7 percent per year and a 50 percent chance of earning 21 percent per year. Its expected return is also 14 percent ($\frac{1}{2} \times 7 + \frac{1}{2} \times 21 = 14$), but it is more risky – the firm could hit it big or do pretty poorly. In general, the less risky project will appear worthwhile at a

12.10
The Investment Function



The investment function is a downward sloping relationship between investment and the real rate of interest for a given level of real returns to investment. An increase in real returns shifts the function upwards and results in an increase in investment for each level of real rates of interests.

lower rate of interest than the more risky project. More risky projects must give higher returns than less risky projects for the same opportunity cost if the investment to appear attractive to the firm. Investment, is then, inversely related to risk. The higher the risk, the lower the investment for each real rate of interest. An increase in risk shifts the investment function downwards.

Investment and Finance (and Other Factors)

Capital markets are *perfect* when firms (or people) can borrow as much as they like at the market rate of interest. When capital markets are perfect, investment should be determined entirely by its opportunity cost and risk. In practice, however, not all firms have unfettered access to lending. Banks may reduce their own risk by limiting the amount that they are willing to lend even if the firm would willingly pay a higher rate of interest to borrow more. Firms with lower credit ratings may have a limited ability to raise funds through the sale of bonds to take the place of rationed bank loans. As a result, how much the firm invests may depend on the availability of credit. If monetary policy actions make banks more willing to lend, and more of the pent up demand for loans can be satisfied, firms may invest more. Greater availability of finance shifts the investment curve upwards at each real rate of interest.

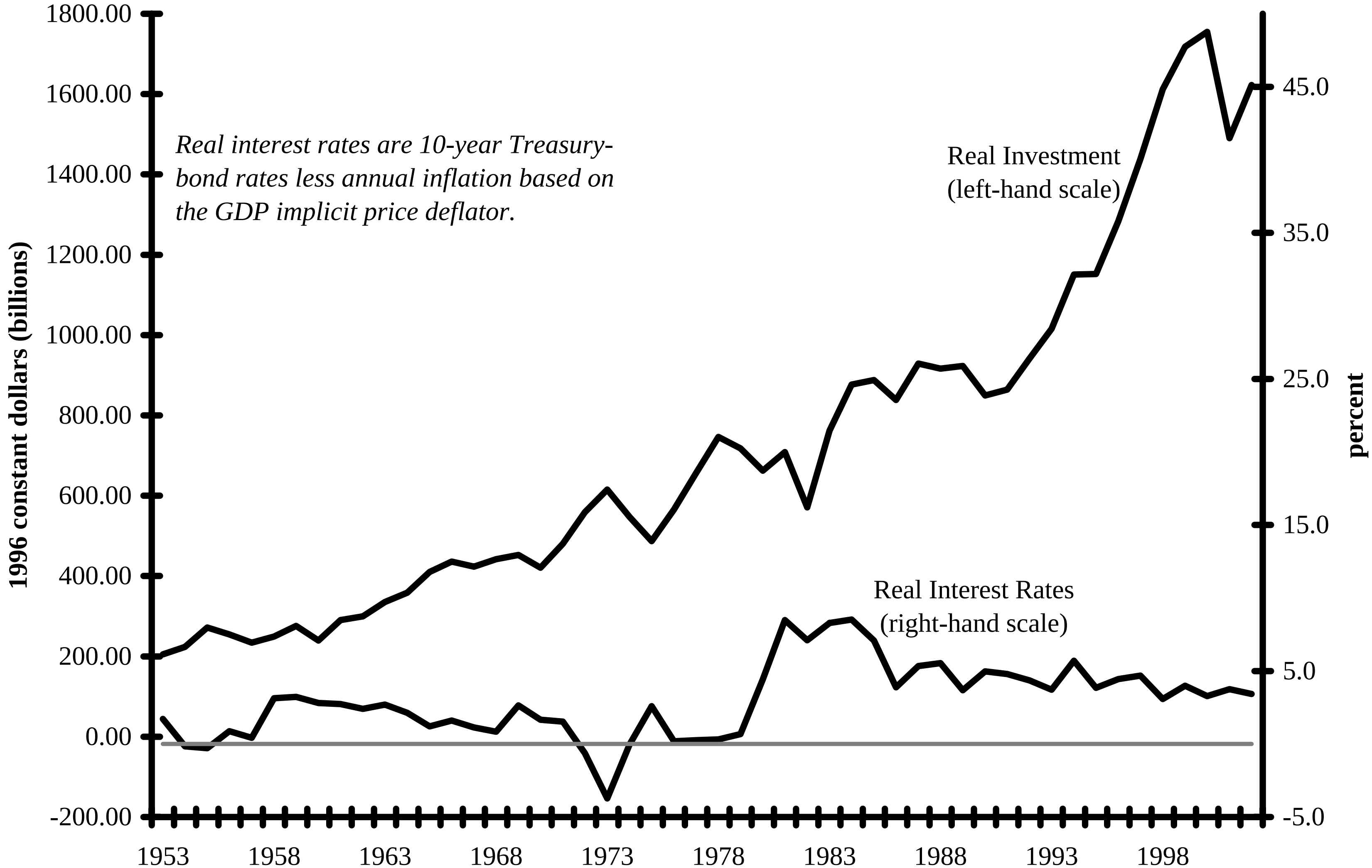
In principle, nothing else aside from opportunity cost, risk, and access to finance should matter to investment. But notice that, since all of the action with any investment project is in the future, the return and risk cannot be observed directly. Neither the firm nor the economist has a crystal ball, and each must form guesses about the future. As a result, investment will also be correlated with anything that helps to predict future returns or risk. Current GDP or the current level of the capital stock or current profits or other measures of economic activity or indicators of where the economy is in the business cycle might help to predict future returns and risk.

12.3.2 The Investment Function in Practice

Figure 12.11 plots the time series for real investment and for the real interest rate for the United States. There is a striking difference between the two series. Real interest rates are approximately stationary; they vary within a narrow range and display no long term trend. In contrast, real investment is non-stationary; it grows steadily on trend. (See the *Guide*, sections G.5.2 and G.14, on stationary and non-stationary data and on relations between them.) These properties of the data imply that investment cannot be represented by a simple function of the form $I = f(rr)$. Real interest rates frequently return to similarly levels. Such a function would imply that investment too should return to the corresponding levels. But in fact, a particular level of real interest rates is associated with a much higher level of investment late in the sample than early in the sample.

A reasonable way of dealing with the relationship between the two series is to recognize that the importance of investment depends on the size of the economy. A level of real investment that is large in a small economy will be small in a large economy. We can easily capture this difference by expressing investment as a share of potential output (that is, as scaled investment $\tilde{I}$). Scaled variables are, of course, bound between 0 and 100 percent and cannot grow on trend. The investment function could, then, be expressed as $\tilde{I} = f(rr)$: the higher the real rate of interest, the lower scaled investment.

Figure 12.11
U.S. Real Investment and Real Interest Rates



Source: interest rates, Federal Reserve; investment and implicit price deflator, Bureau of Economic Analysis.

12.3.3 THE IS CURVE

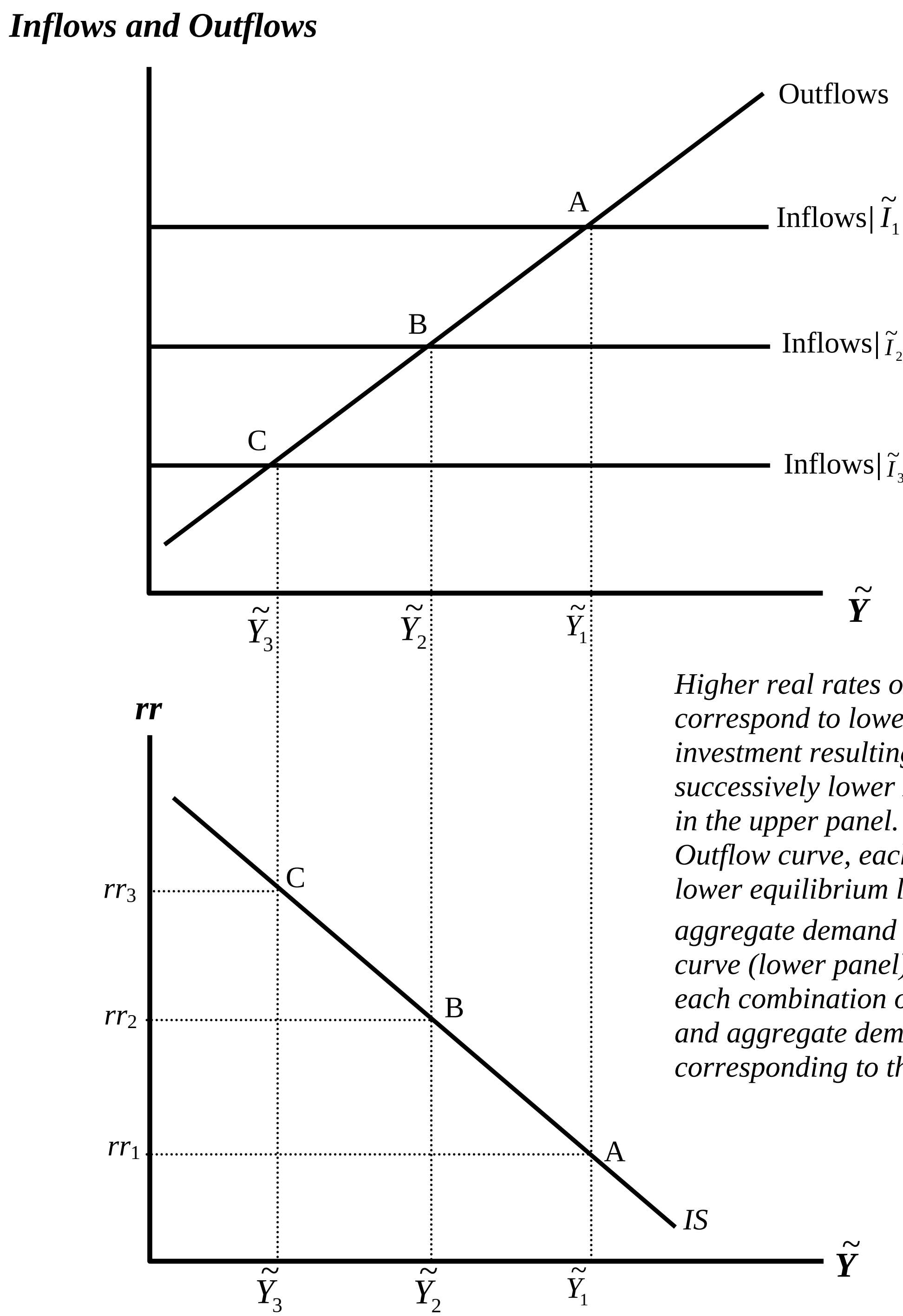
To integrate investment behavior into our simple model of aggregate demand, we translate the inflow-outflow diagram (for example, Figure 12.6) into a diagram with aggregate demand on the horizontal axis and the real rate of interest on the vertical axis. In keeping with the conclusion of the last section, we express aggregate demand as a share of potential GDP (scaled output $\tilde{Y}$).

Deriving the IS Curve

The top panel of Figure 12.12 is essentially the same as Figure 12.7. However, now we will regard investment not as an exogenous component of autonomous spending, but as a decreasing function of real interest rates. The bottom panel shows real interest rates on the vertical axis and aggregate demand on the horizontal axis. Consider three real rates in ascending order: $rr_1 < rr_2 < rr_3$. Say that at the lowest real rate (rr_1), investment is $\tilde{I}_1$. It contributes to the inflows to the domestic private sector indicated by the upper horizontal line in the top panel. The equilibrium is at point A with aggregate demand $\tilde{Y}_1$. The combination of rr_1 and $\tilde{Y}_1$ is shown on the bottom panel – also as point A.

When the real rate rises to rr_2, investment falls to $\tilde{I}_2$. If government expenditure and exports remain unchanged, the fall in investment shifts the Inflow curve down to the middle line. The equilibrium moves to point B, at the reduced aggregate demand $\tilde{Y}_2$. Again, this corresponds to point B in the lower panel ($\tilde{Y}_2$, rr_2). A further increase in real rates of rr_3 results in a further fall in investment to $\tilde{I}_3$, a further shift of the Inflow curve, and a further shift of the equilibrium to point C in both the top and bottom panels.

Figure 12.12
Derivation of the IS Curve



Higher real rates of interest (rr) correspond to lower levels of investment resulting in successively lower Inflow curves in the upper panel. For a given Outflow curve, each results in a lower equilibrium level of aggregate demand ($\tilde{Y}$). The IS curve (lower panel) is locus of each combination of real rates and aggregate demand corresponding to these equilibria

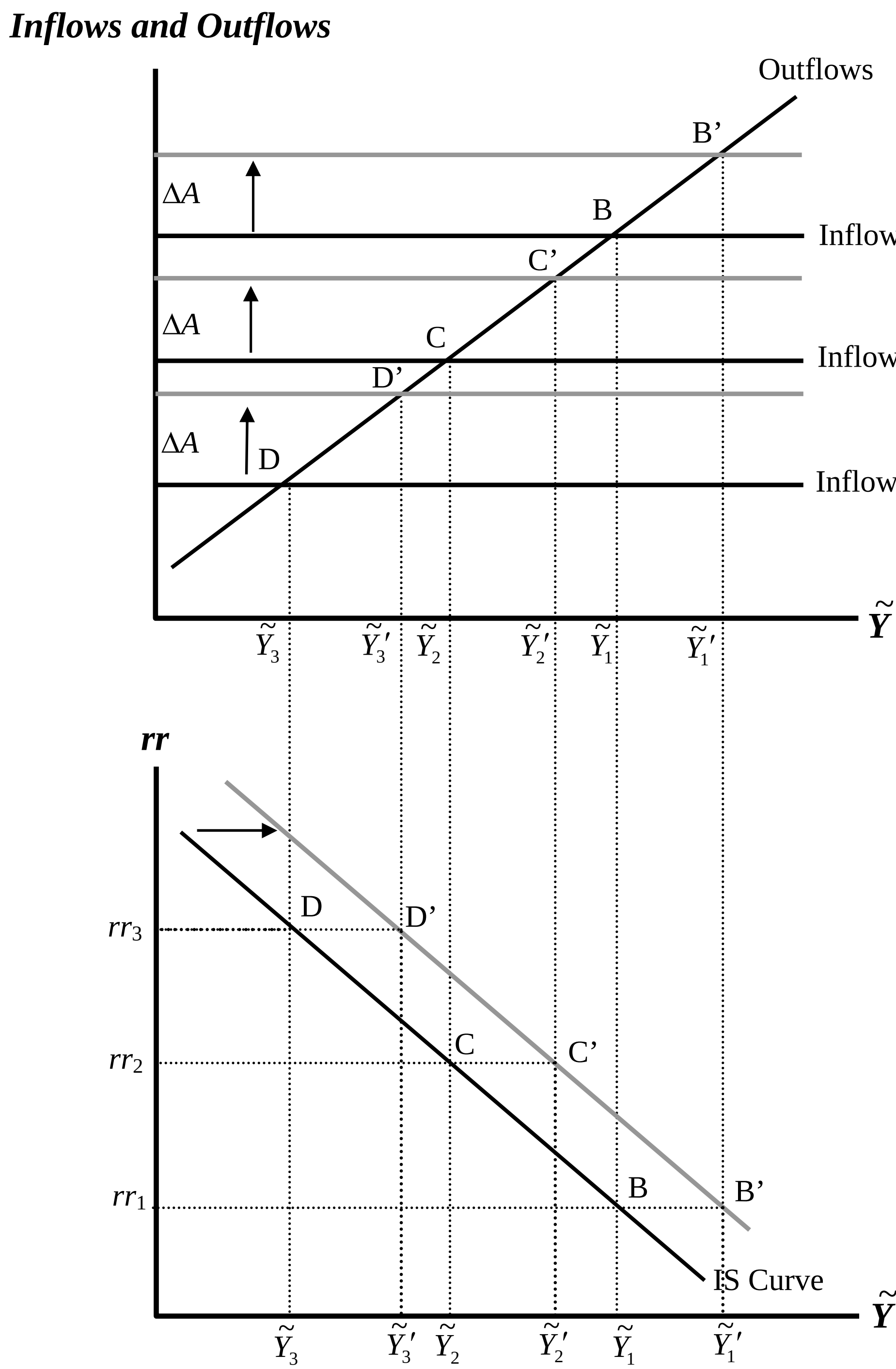
Clearly, any increase in real rates will result in lower investment and a lower equilibrium aggregate demand. Each equilibrium in the top panel can be mapped onto a point in the bottom panel. The line that connects all such points in the lower panel is known as the *IS curve*. (The IS curve apparently takes its name from the initial letters of *I*nvestment and *S*avings. The first IS curve is due to Sir John Hicks (1903-1989), winner of the Nobel prize in economics in 1972.) The **IS CURVE** can be defined as *the locus of all combinations of real rates of interest and aggregate demand for which plans to invest, given other flows of funds into the domestic private sector (government spending, transfer payments, and exports), are compatible with plans to save, given other flows of funds away from the domestic private sector (taxes and imports).*

An Increase in Autonomous Spending Shifts the IS Curve to the Right

The IS curve in Figure 12.12 was drawn for given levels autonomous spending and for given marginal propensities to consume and marginal (net) tax rates. What happens to the IS curve when any of these given values change? Consider first an increase in autonomous spending (for example, an increase in government spending or a rise in exports).

Figure 12.13 shows the effect of an increase in autonomous spending on the derivation of the IS curve. The black lines correspond to those in Figure 12.12, where each horizontal line represents the different level of autonomous spending that results from the level of investment changing with the real rate of interest. If autonomous spending rises, say by ΔA, then each of these lines would shift upwards as shown to the corresponding gray lines. For example, the top two lines in upper panel represent inflows

Figure 12.13
An Increase in Autonomous Spending
Shifts the IS Curve Right



when the real interest rate is rr_1 before and after the increase in autonomous spending. The equilibrium in both the upper and lower panels shifts from B to B' (raising aggregate demand from $\tilde{Y}_1$ to $\tilde{Y}_1'$).

Exactly the same thing happens with the inflow lines that correspond to other interest rates: the equilibrium point C shifts to C' and D to D'. A new IS curve (shown as a gray line) connects all such equilibrium points in the lower panel. It lies to the right of the original IS curve. An increase in autonomous spending results in rightward shift, and a decrease in a leftward shift, of the IS curve.

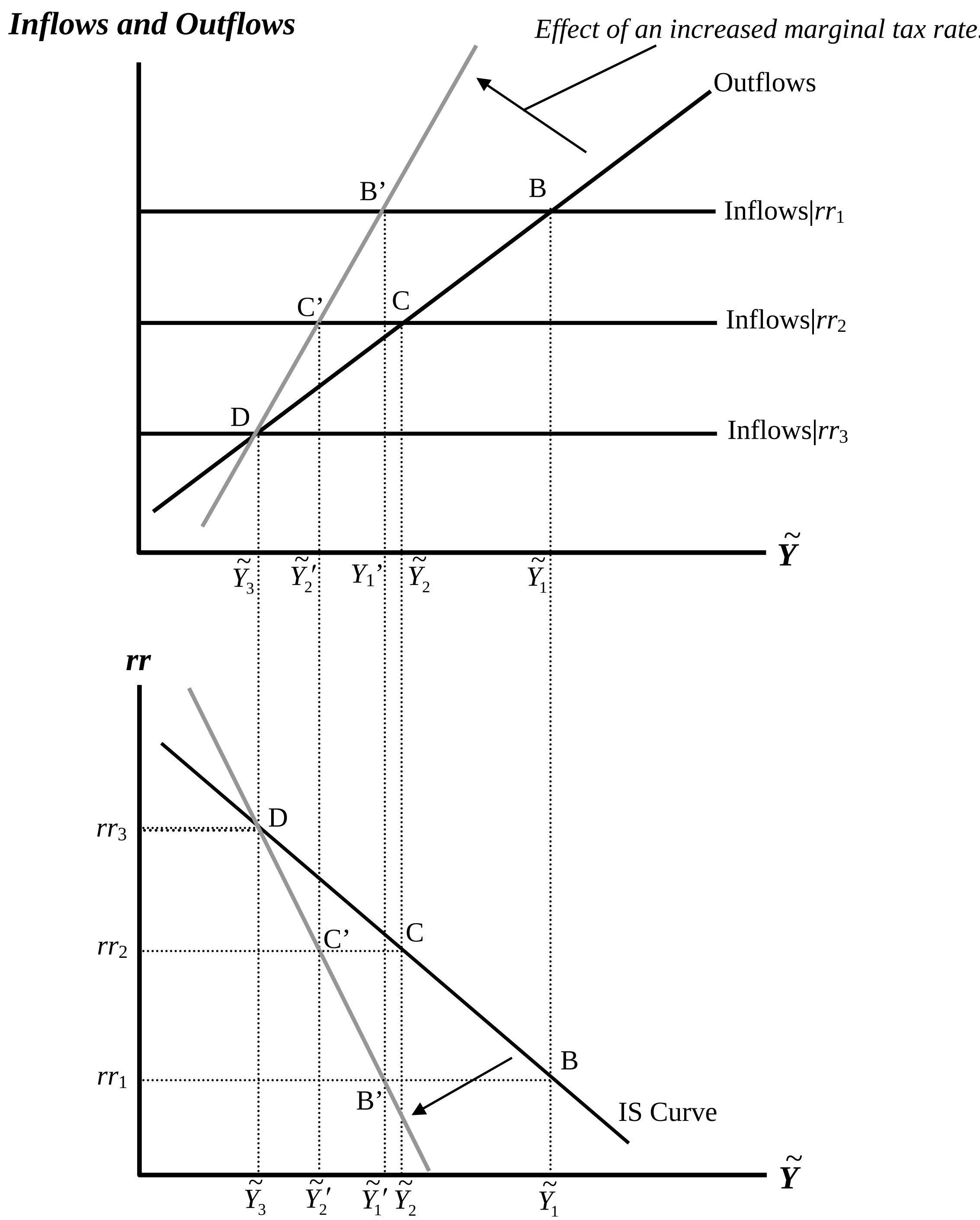
A Increase in the Rate of Return on Investment Shifts the IS Curve to the Right

Figure 12.12 was drawn on the assumption that the return to investment, ρ, was constant, so changes in real rates of interest were the only source of changes in the desirability of investment relative to other opportunities. Any increase in ρ, holding *rr* constant, results in an increase in investment. Such an increase in investment at a constant real rate results in exactly the same sort of vertical shift of the Inflow curve in Figure 12.13 as an increase in government expenditure or net exports. It has exactly the same effect on the IS curve, shifting it rightward.

An Increase in Marginal Tax Rates Pivots the IS Curve Downward

Figure 12.14 shows the effect of an increase in the marginal tax rate (t). Again, the black lines correspond to those in Figure 12.12. We know from Figure 12.8 that an increase in t steepens the Outflow curve. The heavy black Outflow curve corresponds to the lower tax rate, while the gray line corresponds to a higher tax rate. The intersection of the

Figure 12.14
An Increase in the Rate of Taxation Steepens the IS Curve



An increase in the marginal rate of taxation, steepens the Outflow curve and the IS curve.

Inflow and the Outflow curves when the real rate of interest is rr_1 at the lower tax rate was at point B. When the tax rate rises, it moves to point B'. Exactly the same thing happens with equilibrium point C, which shifts to C'. (It makes the diagram easier to read to treat point D as the pivot point.)

Each new equilibrium point corresponds to a lower level of aggregate demand for the same real rate of interest. The new IS curve (gray line) connects all such equilibrium points in the lower panel. It lies to the left of, and is steeper than, the original IS curve. An increase in the marginal rate of taxation results in leftward shift, and a decrease in a rightward shift, of the IS curve.

Since the slope of the Outflow curve is steeper not only when taxes are higher, but when the marginal propensity to save is higher, an increase in the marginal propensity to save (that is, a decrease in the marginal propensity to consume) would result in a leftward shift and a steepening of the IS curve. A decrease in the marginal propensity to save would result in rightward shift and a flattening of the IS curve.

The IS Curve and the Multipliers

At any given real rate of interest, the horizontal shifts in the IS curve correspond exactly to the changes in aggregate demand implied by the various multipliers. The movement along the IS curve corresponding to a change in the real rate of interest corresponds exactly to the resulting change in investment times the consumption multiplier. The principal difficulty with using the IS curve is this: one must know the real rate of interest to know where along the curve the economy finds itself. In Chapters 10 and 11 and, later, in Chapter 17 on monetary policy, we show that real rates depend on the interaction of monetary policy, financial markets, the profitability of real capital investment, and inflation.

Numerical Examples

It is easy to understand the IS curve through an extension of illustrative model discussed in earlier sections. Start with the benchmark model of section 12.2.1. But now we will assume that potential GDP is Y^{pot} = 4,000 and re-express all the levels as percentage shares of scaled output (for example, if G = 500, then $\tilde{G}$ = 500/4,000 = 12.5 percent).

Illustrative Model: Case 5

Now, however, let investment behavior be described by a linear equation in which ρ is assume to be 3 percent:

(12.36) $$\tilde{I} = i_0 - i(rr - \rho) = 8.75 - 1.25(rr - 3).$$

(Notice that the real rate and ρ are measured in percentage points, so that 3 percent is written “3” and not “0.03”.)

If in equation (12.26) we replace one of the values of 500 with the investment function (12.36) and the other value of 500 with the variable G, we obtain

$$350 - 50(rr - 3) + \tilde{G} = (1 - 0.8)(\tilde{Y} - (1/6)\tilde{Y}) + (1/6)\tilde{Y} = 1/3\tilde{Y}.$$

Solving for $\tilde{Y}$ yields the IS curve:

(12.37) $$\tilde{Y} = 26.25 + 3\tilde{G} - 3.75(rr - 3).$$

(Contrary to the common practice of mathematics, the IS curve is typically drawn with aggregate demand ($\tilde{Y}$) on the horizontal axis, even when, as here, it is written as the dependent variable in the equation.)

To see how the IS curve works, start with a simple case in which $\tilde{G}$ = 12.5 percent and rr = 0. According to equation (12.36), investment $\tilde{I}$ = 12.5 percent; and, according to the IS curve, aggregate demand $\tilde{Y}$ = 75 percent. This is closely related to the earlier Case 1 in Section 12.2.1: when investment is at the same level as in Case 1, aggregate demand is also the same (since 75 percent of 4,000 is 3,000).

Illustrative Model: Case 6

What happens if real rates of interest increase, say, to 5 percent? Then, according to equation (12.36), investment falls to $\tilde{I}$ = 6.25 percent; and, according to the IS curve, aggregate demand falls to $\tilde{Y}$ = 56.25 percent. The drop in aggregate demand corresponds to a movement along the IS curve. Notice that the consumption multiplier is

$\mu = \dfrac{1}{1-c(1-t)} = \dfrac{1}{1-0.8[1-(1/6)]} = 3$. The increase in interest rates results in

$\Delta\tilde{I}$ = –6.25 percent and $\Delta\tilde{Y}$ = 75 – 56.25 = –18.75, exactly as predicted by the multiplier.

Illustrative Model: Case 7

Another case: keep real rates at 5 percent, but increase government spending by 100 (i.e., 2.5 percent), so that $\tilde{G}$ = 15 percent. Aggregate demand rises by 7.5 percent to $\tilde{Y}$ = 63.75 percent. Since the consumption multiplier is the same for both investment and government expenditure ($\mu = 3$), this is again just what the multiplier predicts. The increase in government expenditure corresponds to a rightward shift of the IS curve at each real rate of interest. (In Problem 12.11 you are asked to demonstrate that an increase in the marginal (net) tax rate (t) results in leftward shifts of the IS curve.)

12.4 The Limits to Aggregate Demand Management

What lessons should we draw from our understanding of aggregate demand? At first blush, it might seem that the multipliers or the IS curve give us a recipe (in former President Clinton's infelicitous phrase) to "grow the economy." Any increase in government expenditure apparently raises aggregate demand, so why not just keep increasing expenditure until GDP is as large as we like?

Recall also that any increase in the marginal propensity to consume results in a larger multiplier. So why not encourage people to consume more and save less to raise aggregate demand? Such suggestions are often heard when economies are deeply depressed (as, for example, the Japanese economy was through most of the 1990s and into the new millennium).

12.4.1 The Paradox of Thrift

Consider a different illustrative model. (We are once again working with the levels of real variables rather than their scaled equivalents.)

Illustrative Model: Case 8

Initially let the consumption function be $C = 0.9Y$, investment $I = 500$, and government spending $G = 500$ (net exports and transfer payments are both zero). And, to keep things simple, let the tax rate $t = 0$. The consumption multiplier (see equation (12.17)) is $\mu = \frac{1}{1-c(1-t)} = \frac{1}{1-0.9(1-0)} = 10$, equilibrium aggregate demand is $Y = 10{,}000$, and savings is $S = (1-c)Y = 1{,}000$.

Now imagine that the government is concerned with increasing resources available for investment. Since $Y = C + I + G$, they reason that by cutting back on consumption and, therefore, by raising savings rates more investment could be financed. So they exhort the population to reduce the marginal propensity to consume. Assume that the marginal propensity to consume falls from $c = 0.9$ to $c = 0.8$. The multiplier falls from $\mu = 10$ to $\mu = 5$, and aggregate demand falls from $Y = 10{,}000$ to $Y = 5{,}000$. What happens to savings? Answer: nothing! Before savings $S = (1 - 0.9) \times 10{,}000 = 1{,}000$. Now $S = (1 - 0.8) \times 5{,}000 = 1{,}000$.

This situation is known as the **paradox of thrift:** *higher rates of savings reduce aggregate demand without increasing the resources available for investment, even though consumption is reduced*. The flip side of the paradox is that an increase in the marginal propensity to consume (say to c = 0.95) appears to promote higher GDP with no loss to the resources available for investment. It is too good to be true.

12.4.2 Resource Constraints

Remember that GDP is determined by the interaction of aggregate demand and aggregate supply. In this chapter, we have largely ignored aggregate supply. All of our models presume that aggregate supply was not a constraint in the sense that anything demanded would be supplied in any quantity without any increase in prices. (We address what happens when this is not the case in more detail in Chapter 16.) Such an assumption is reasonable when there are spare resources in the economy. In a recession, for instance, there are unemployed workers and idle plant and equipment. More demand can easily be supplied. Additional government expenditure or a cut in interest rates that promotes additional investment can then have a multiplied influence on aggregate demand, and supply rises as the unused resources are put to work.

But what if an economy is working at full capacity – the unemployment rate is low and plant and equipment is running at full tilt – as it might be near the peak of the business cycle? In that case, more resources – particularly, more physical capital – must be added to the economy or else supply cannot rise to meet the demand. An expansion of government expenditure or a cut in interest rates at such a juncture would stimulate demand, but GDP could not rise. Where would the increased demand go? Some of it would be absorbed in the mismatch between the plans of firms and the plans of consumers. Firms would find themselves running their inventories down (unplanned disinvestment). This is unlikely to be satisfactory, so they will also look for ways to expand production – that is, ways to invest. Of course, in the face of high demand, firms can raise prices, which will itself reduce some of the demand. And, some of the demand may spill over into imports, so that foreigners supply the increase.

The paradox of thrift – like all true paradoxes – only appears to be contradictory. Investment and economic growth require additional resources, and those resources must be saved if they are to be used. Yet the attempt on the part of consumers to supply those resources results in lower aggregate demand and unchanged savings.

The resolution of the paradox brings us back to the observation of Chapter 2, section 2.7: the plans of the different actors in the economy are not necessarily coordinated. When savers increase their rates of saving, more resources are made available to firms, only if the firms choose to take advantage of them and to invest. In our example, if firms had raised the level of investment at the same time that households increased their savings, aggregate demand would have increased. Even if households maintain an *unchanged* marginal propensity to consume, any time investment increases, savings also increase, since the same fraction of a higher aggregate demand yields a higher level of savings. The higher level of investment lays the groundwork for the increased capacity of the economy to supply goods and services.

Aggregate demand can never expand beyond the limit set by available resources; but aggregate demand can fall short of that limit. Any negative shock to aggregate demand can start a multiplier process that draws the economy below it productive capacity. Similarly, when the economy is already below its productive capacity, any positive shock to aggregate demand can start a multiplier process that pushes the economy back towards full capacity. Any attempt to push aggregate demand beyond the available resources can result only in rising prices, falling inventories, and a widening trade deficit. Once resources are fully used, further increases in GDP require additional resources, and not demand management.

Appendix: The IS-LM Model

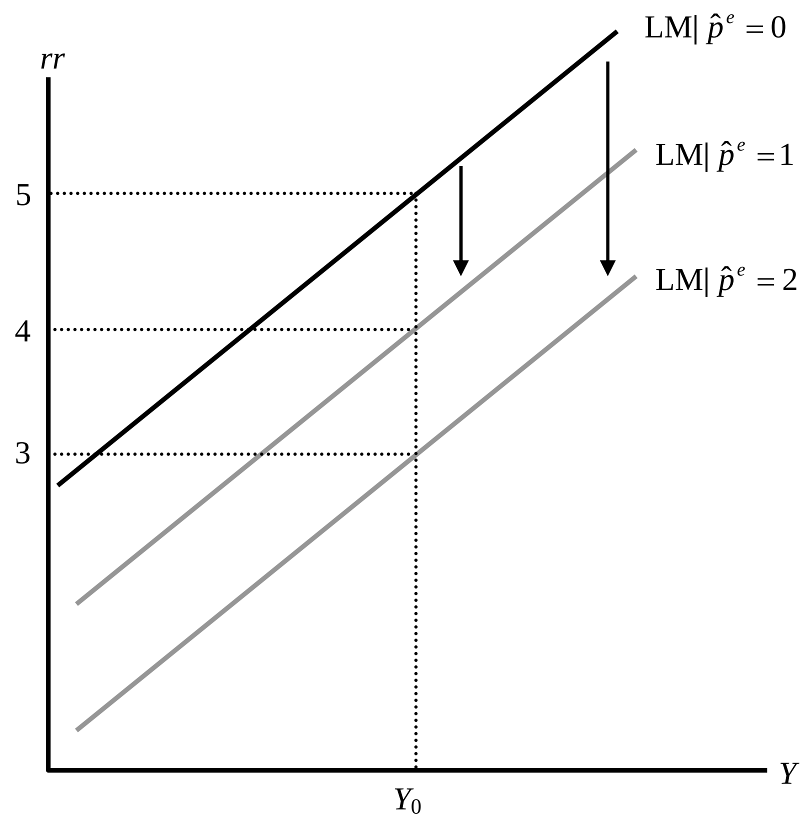
The IS curve can be combined with the LM curve (Chapter 11, Appendix) on a single diagram to provide a complete model of aggregate demand.

12.A.1 The LM Curve and Expected Inflation

We have drawn the IS curve as a function of real interest rates and the LM curve as a function of market (nominal) interest rates. To put the curves onto a single diagram one or the other must be re-expressed. For our purposes, it is easiest to re-express the LM curve as a function of real interest rates. To top line in Figure 12.A.1 shows the LM curve when expected inflation is zero ($\hat{p}^e = 0$). In this case, real and nominal interest rates coincide: $r = rr + \hat{p}^e = rr + 0 = rr$.

Consider what happens when expected inflation increases, say, to 1 percent per year. On any point along the LM curve, a particular level of aggregate demand corresponds to a particular *nominal* interest rate. For example, Y_0 corresponds to $r = 5$. If expected inflation rises by 1 point, then $r = 5$ corresponds to a real rate of 4 (= $r - \hat{p}^e = 5 - 1$). Thus, when the expected inflation rate rises by 1 point the whole LM curve (drawn with real rates of interest on the vertical axis) must shift down by 1 point as shown by the

Figure 12.A.1
The LM Curve and Expected Inflation



Although naturally drawn with nominal rates of interest on the vertical axis, the LM curve can be translated onto a diagram with real rates instead. A particular level of aggregate demand (say, Y_0*) corresponds to a particular nominal interest rate. The black curve shows that when the expected rate of inflation is zero, the nominal and real rates coincide and* Y_0 *corresponds to 5 percent (nominal and real). When expected inflation rises to 1 percent, a nominal rate of 5 percent corresponds to a real rate of 4 percent, and the LM curve shifts down by one point. Similarly, when expected inflation rises to 2 percent, a nominal rate of 5 percent corresponds to a real rate of 3 percent, and the LM curve shifts down two points.*

middle LM curve. Similarly, if expected inflation were to rise by 2 points, the LM curve would shift down by 2 points as shown by the lower curve.[2]

12.A.2 Working with the IS-LM Model

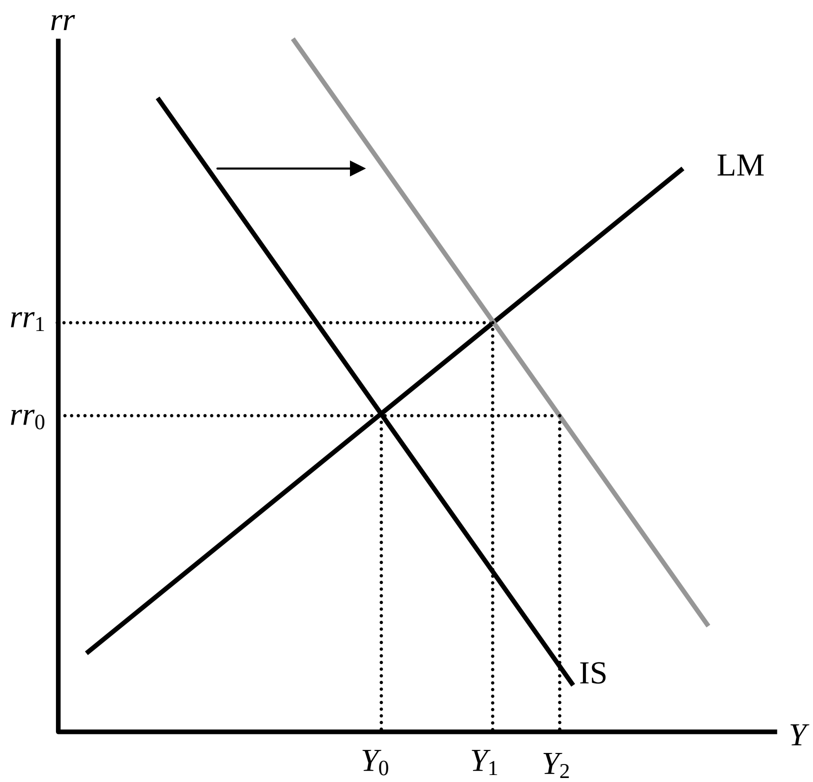
Figure 12.A.2 shows the IS and LM curves on the same diagram. The crossing point determines both the levels of aggregate demand and real rate of interest. Anything that shifts either curve shifts the equilibrium levels of these variables. Consider a few illustrative cases. (Additional cases are considered in Problems 12.13-12.15.)

An Increase in Government Expenditure

As we know from section 12.3.2, any increase in autonomous expenditure (including an increase in *G*) shifts the IS curve to the right as shown in Figure 12.A.2. We can see immediately that aggregate demand rises (from Y_0 to Y_1), as we already knew to expect. The IS-LM model also suggests that the real interest rate will rise (from rr_0 to rr_1). The mechanism is that the increased aggregate demand increases transactions demand for money. But since the supply of money is assumed to be fixed, nominal interest rates must rise to keep the supply and demand for money in equilibrium. For a given level of expected inflation, a rise in nominal interest rates is equivalent to a rise in real interest rates. Higher real interest rates reduce investment, which has a negative multiplier effect that partly offsets the positive multiplier from increased government spending.

[2] Instead of drawing the LM curve on a graph with real rates on the vertical axis, we could have drawn the IS curve on a graph with nominal interest rates. In that case, the IS curve would shift vertically upwards point for point with expected inflation.

Figure 12.A.2
The IS-LM Model: An Increase in Government Spending



An increase in government spending shifts the IS curve to the right raising aggregate demand and real interest rates. The standard multiplier effect is shown by the increase in aggregate demand to Y_2 *with real interest rates constant at* rr_0*. But the endogenous rise in interest rates reduces investment, producing an offsetting multiplier effect that reduces aggregate demand partly to* Y_1.

We can relate the IS-LM model to the analysis of the IS curve in section. There when we considered an increase in government expenditure, we assumed that real rates of interest would remain constant at rr_0, so that aggregate demand would rise to Y_2. The increase in aggregate demand ($Y_2 - Y_0$) is the fully multiplied effect of ΔG. In the IS-LM model, however, real rates of interest are not held constant, but are endogenous. The increase in aggregate demand ($Y_1 - Y_0$) is the multiplied effect of ΔG less the offsetting multiplied effect of the fall in investment as a result of the induced rise real rates.

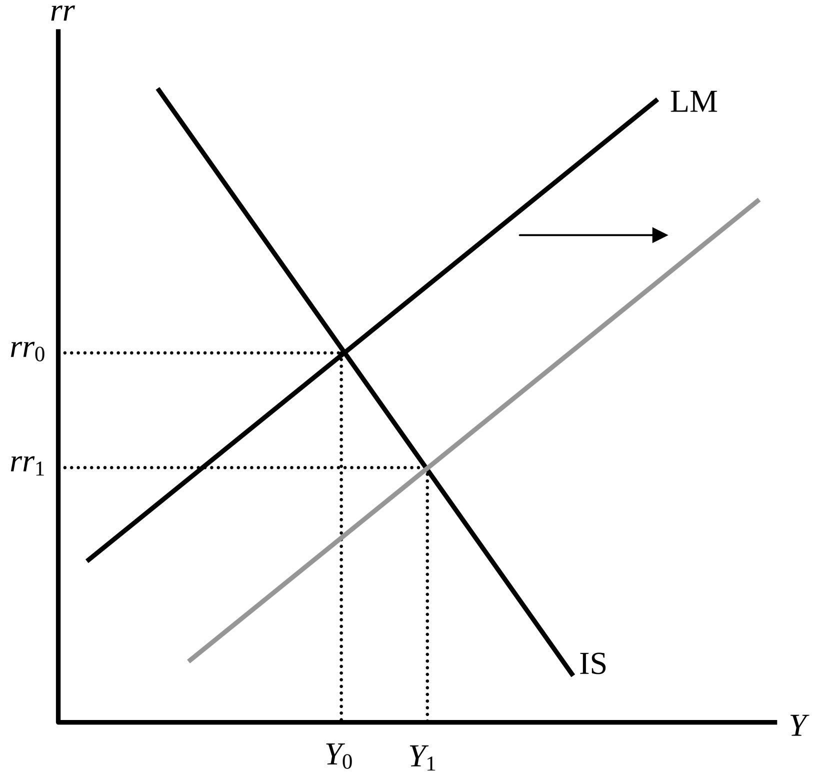
An Increase in the Money Supply

As we know from Chapter 11, section 11.A.2, an increase in the nominal supply of money *ceteris paribus* increases the real supply of money and shifts the LM curve to the right. As shown in Figure 12.A.3, aggregate demand rises (from Y_0 to Y_1), and real interest rates fall (from rr_0 to rr_1). With a higher stock of money, the supply would exceed the demand. In order to restore equilibrium to the money market, the nominal rate of interest must fall until the demand is equal to the supply. At a constant expected rate of inflation, this fall in nominal rates translates into a fall in real rates; which, in turn, stimulates investment. The additional investment has a multiplied effect on aggregate demand.

An Increase in the Rate of Inflation

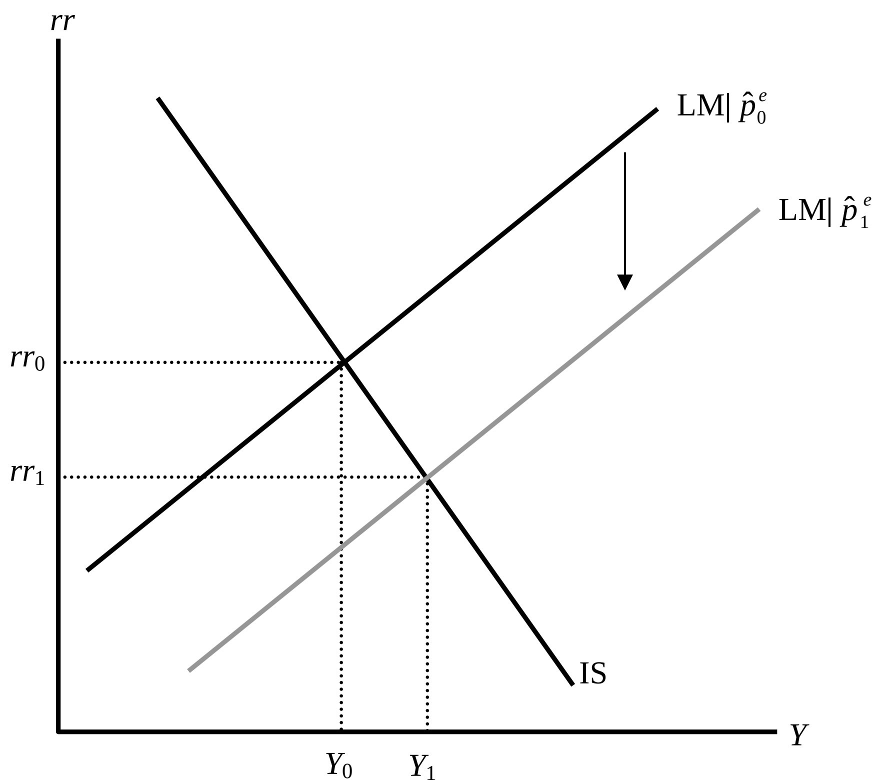
As we saw in section 12.A.1, an increase in the rate of inflation shifts the LM curve downward point for point. Figure 12.A.4 shows that this results in an increase in aggregate demand (from Y_0 to Y_1) and a fall in real interest rates (from rr_0 to rr_1).

Figure 12.A.3
An Increase in the Money Supply



An increase in the supply of money shifts the LM curve to the right, raising aggregate demand and lowering real interest rates.

Figure 12.A.4
An Increase in the Money Supply



An increase in the expected rate of inflation ($\hat{p}_0^e < \hat{p}_1^e$ *) shifts the LM downward, raising aggregate demand and lowering real interest rates.*

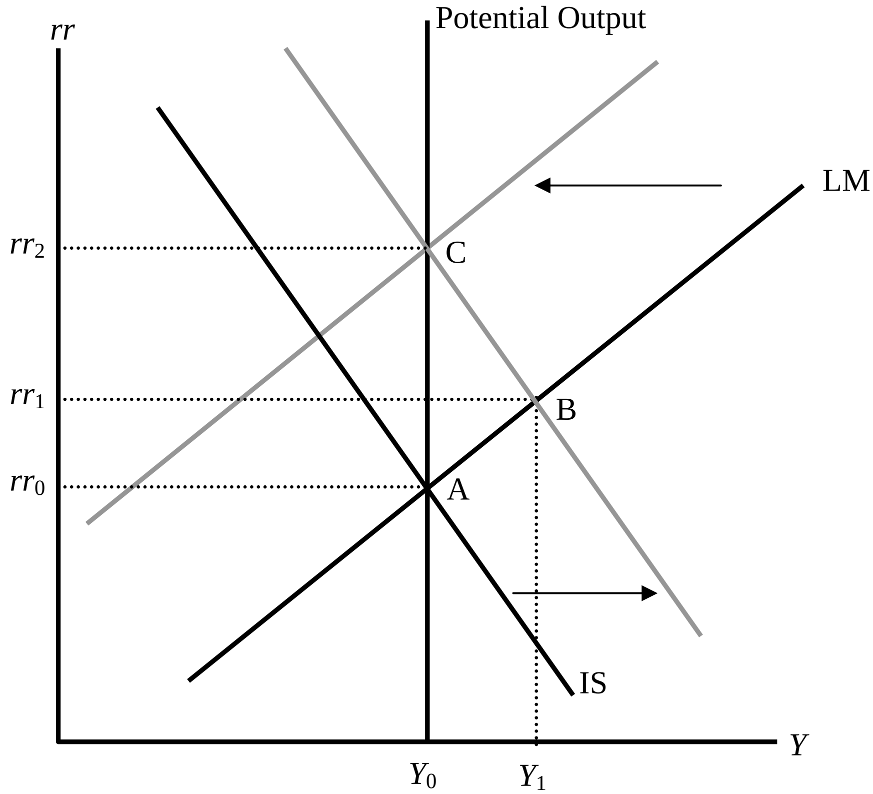
Although the LM curve shifts, the action is not in the money market (the shift is just an accounting fact that results from our having drawn the LM curve on a graph with real interest rates instead of the more natural nominal interest rates). The increase in the rate of inflation for a fixed nominal rate of interest reduces the real rate of interest point for point. The lower real rate stimulates investment, which has a multiplied effect on aggregate demand. The surprising result that higher anticipated inflation stimulates demand is sometimes known as the *Mundell-Tobin effect* named for Robert Mundell of Columbia University (winner of the Nobel Prize in 1999) and the late James Tobin (1918-2002) of Yale University (winner of the Nobel Prize in 1981).

12.A.3 The IS-LM Model at Full Employment

Each of the cases considered in the last section assumed that aggregate supply was not a constraint on aggregate demand – that is, that the economy was at less-than-full employment. What happens when the economy is already fully employed and aggregate demand increases? Just to take one case, consider once again an increase in government expenditure. Figure 12.A.5 shows the initial equilibrium at point A (Y_0, rr_0). The vertical line through point A indicates the full-employment level of aggregate supply – that is, potential output.

An increase in government expenditure shifts the IS curve to the right. If aggregate supply were not a constraint, the equilibrium would shift to point B (Y_1, rr_1). But point B is not feasible, since there aggregate demand exceeds aggregate supply. In such a situation, firms raise prices (section 12.4). An increase in the price level reduces the real supply of money, shifting the LM curve to the left (Chapter 11, section 11.A.2).

Figure 12.A.5
An Increase Government Spending at Full Employment



When the economy is already at full employment, an increase in government spending, shifting the IS curve to the right, would ordinarily shift the equilibrium from point A to point B with higher aggregate demand ($Y_1 > Y_0$) and a higher real rate of interest ($rr_1 > rr_0$). This cannot be sustained because aggregate demand would exceed aggregate supply (Y_0). Full equilibrium requires higher prices, which reduce the real money supply, shifting the LM curve leftwards until it intersects the IS curve at the level of potential output (point C). At this point, all markets are in equilibrium; the economy is producing at full potential; and the higher real rate of interest reduces investment, freeing up resources for the increased level of government spending.

To restore equilibrium, the increase in the price level must be great enough to move the intersection of the LM curve with the new IS curve back to equality with aggregate supply at point C. Here the original level of aggregate demand is restored to Y_0 and the real interest rate is even higher at rr_2.

At the new equilibrium, the economy is no bigger than before, but output is distributed differently. Since the size of the pie is unchanged, the increase in government expenditure must be at the expense of some other sector. Here the increased real rate of interest reduces the level of investment by exactly enough to fund the additional government spending. This phenomenon is sometimes referred to as the *crowding out* of private spending by government spending. Crowding out is discussed in more detail in Chapter 18.

Summary

1. GDP is determined by the interaction of aggregate supply and aggregate demand. The components of aggregate demand are given by the right-hand side of the product-expenditure identity: $Y \equiv C + I + G + NX$. A theory of aggregate demand explains the economic behavior behind each of the components. Equilibrium occurs when the plans of all the economic actors are compatible.
2. Consumption depends on many factors. The consumption function relates consumption to its most important determinant – disposable income. The marginal propensity to consume (mpc) is defined as the small increase in saving that results from a small increase in (disposable) income and is the slope of the consumption

function. The mpc is greater than zero and less than one. In theory, the mpc is less than or equal to the average propensity to consume (apc).

3. Data for the United States suggest that a good approximation of consumption behavior sets the mpc equal to the apc, so that the consumption function passes through the origin.
4. Taxes are generally a function of income. The marginal tax rate is greater than zero and less than one. Data for the United States suggest that a good approximation for the tax function sets the marginal tax rate to a constant equal to the average tax rate.
5. A simple model of aggregate demand substitutes the consumption and tax functions into the national-income-accounting identities. In such a model, an increase in autonomous spending on investment, government goods and services, or net exports raises GDP by a multiplied amount. The initial spending or inflow becomes income for consumers, who in turn spend some and save some, creating income for other consumers. The pattern repeats until the initial spending is absorbed in increased savings or other outflows. The consumption multiplier measures the ratio of the increase in GDP to the initial increase in autonomous spending.
6. The consumption multiplier is larger, the higher the marginal propensity to consume. It is smaller the higher the marginal tax rate (or other rates of outflow).
7. A model of aggregate demand can be used to guide fiscal policy – that is, government policy with respect to spending and taxes. Increases in spending boost aggregate demand by an amount given by the autonomous expenditure multiplier; increases in taxes lower it by an amount given by the tax multiplier.

8. The autonomous expenditure multiplier is larger than the tax multiplier. An increase in autonomous spending has a direct effect, because it is a component of GDP itself, and indirect or multiplied effects. A tax increase has only indirect effects, because taxes and transfers are not part of GDP. As a result a balanced-budget increase in which autonomous spending and taxes rise by exactly the same amount adds to GDP just the amount of the increase in autonomous spending (i.e., the direct effect). The indirect effect of autonomous spending is offset by the indirect effects of the tax increase. The balanced-budget multiplier is, therefore, unity.
9. Governments usually set tax rates, not tax levels. As a result, any stimulus to aggregate demand that increases in GDP generates additional tax revenue that itself begins a negative multiplier process, partially offsetting the initial stimulus. Offsets due to taxes or other endogenous outflows are known as automatic stabilizers, since they reduce the variability of GDP.
10. The rate of investment is determined by the difference between the real rate of interest and the returns on investment, which measures the opportunity cost of investment; the risk involved in the investment; and the availability of borrowed funds when firms are cash constrained. Higher real interest rates, higher risk, and lower borrowing facilities lower the rate of investment.
11. The IS curve is the locus of all combinations of real rates of interest and aggregate demand for which plans to invest, given other flows of funds into the domestic private sector (government spending, transfer payments, and exports), are compatible with plans to save, given other flows of funds away from the domestic private sector (taxes

and imports). The IS curve summarizes the state of aggregate demand for given levels of real interest rates.

12. On a graph with real interest rates on the vertical axis and real GDP on the horizontal axis, the IS curve is downward sloping. An increase in autonomous expenditure shifts the IS curve to the right, increasing GDP at a constant rate of interest. An increase in tax rates pivots the IS curve down and to the left, decreasing GDP at a constant rate of interest

13. Multiplier processes can increase GDP only when the economy is operating below its full potential. Any increase in aggregate demand at full potential must be absorbed in higher prices or higher outflows from demand – e.g., higher imports or negative inventory investment.

Key Concepts

marginal propensity to
consumption function
average propensity to consume
savings function
consumption multiplier
discretionary fiscal policy
automatic fiscal policy
balanced-budget
investment curve (or function)
IS curve

Suggestions for Further Reading

John R. Hicks, "Mr. Keynes and the Classics," in *Critical Essays in Monetary Theory*. Oxford: Clarendon Press, 1967.

Robert A. Mundell, *Monetary Theory, Inflation, Interest, and Growth in the World Economy*. Pacific Palisades, CA: Goodyear Publishing Co., 1971.

Michel De Vroey and Kevin D. Hoover, editors. *The IS-LM Model: Its Rise, Fall, and Strange Persistence*. Durham, NC: Duke University Press, 2005.

Problems

Data for this exercise are available on the course website under the link for Chapter 12 (**insert web link here**). Before starting these exercises, the student should review the relevant portions of the *Guide to Working with Economic Data*: section G.15.

Problem 12.1. The multiplier formula (2.17) was derived on the assumption that the consumption function passed through the origin – i.e., it took the form given in (12.3) with the intercept c_0 set to zero. Assume that $c_0 \neq 0$ and, following the same steps as the text, derive the three equations analogous to (2.15), (2.16), and (2.17). Note the similarities and differences between these equations and your derivations. What do they tell you about the relationship of the multiplier, the consumption function, and the marginal propensity to consume?

Problem 12.2. In the subsection of section 12.1.4 on the <u>Multiplier Process</u>, we showed using a particular example that the process of spending becoming income becoming spending becoming income ultimately resulted in the multiplier as the static multiplier given in equation (2.17). Prove that this is true in general. Instead of the \$1000 investment expenditure of Boeing, assume that there is an arbitrary increase in autonomous expenditure (ΔA); and instead of the assumption that the marginal propensity to consume mpc = 0.75, assume that $mpc = c$. Derive the analogous expression to (12.21). What is the multiplier? Is it the same as the static multiplier (12.17) when $t = 0$?

Problem 12.3. Although the average propensity to consume in the United States (Figure 12.1) does not trend uniformly downward over the whole post-World War II period, it does trend down until the early 1980s and sharply upwards after that. We might obtain a better estimate of the marginal propensity to consume if we use detrended data. Using the detrending method of your choice, detrend real consumption and real disposable income. Explain your method and your reasons for choosing it. Make a scatterplot of detrended consumption against detrended disposable income. Add the regression line and the regression equation. The slope coefficient is an estimate of the mpc. Compare your estimate to that in the text. Use your estimate and $t = 0.17$ to compute the multiplier. How does it differ from the estimate in the text?

Problem 12.4. Are the marginal propensity to consume and the multiplier stable over time? Look again at Figure 12.1. Choose a date that divides the sample into two parts – one in which the apc is trending downward and one in which it is trending upward. Using the procedure in Problem 12.3 (or just using the calculations that you have already made for that problem), plot the scatterplots and obtain the regression lines, and equations for each of your subsamples. How does the mpc change between the two periods? Calculate the average tax rates for each subperiod and use them as estimates of t. Calculate the multiplier (using equation (12.17)) for each subperiod. Comment on your results.

Problem 12.5. Calculate the average propensity to consume for each of the G-7 countries and plot the results on a time series graph. Calculate the average value for each series. Would a simple consumption function in which $mpc = apc$, adequately describe consumption in these countries? Choose one country other than the United States; and, using the same procedures as in Problem 12.3, obtain an estimate of the *mpc*. Compare and contrast consumption behavior between the United States and your chosen country.

Problem 12.6. Consider an economy with no foreign trade and no transfer payments whose consumption function is given as

$$C = 100 + 0.9(Y - T).$$

(a) Initially let $G = 800$, $T = 800$, and $I = 300$. What is the level of Y? Assuming that taxes follow the simple function, $T = tY$, what is t?
(b) Holding t constant, what is the effect on Y of increasing G by 100 to 900?
(c) What is the effect *ceteris paribus* on Y of decreasing T by 100? At what value must the government set t to achieve this tax cut?
(d) Explain why the effects in (b) and (c) are different.
(e) Suppose that the government wanted to maintain a balanced budget and increased both G and T by 100. What would be the effect on Y? What t would it need to choose to keep the budget balanced?

Problem 12.6. Consider an economy with no foreign trade whose consumption function is given as

$$C = b(Y + TR - T).$$

Taxes are determined as

$$T = tY$$

and transfer payments are determined as

$$TR = tr_0 - trY,$$

where tr_0 and tr are positive constants.

Suppose that initially $b = 0.9$, $t = 0.2$, $tr_0 = 500$, $t = 0.05$; $I = 500$, $G = 1000$.

(a) Sketch the transfer-payment function. Are transfer payments procyclical or countercyclical?
(b) Derive a general formula for the autonomous expenditure multiplier and compute its specific value for this economy. (Note: this multiplier will differ from equation (12.17) because it includes endogenous transfer payments.)
(c) If the tax rate is cut from $t = 0.2$ to $t = 0.15$. How much will aggregate demand (Y) change as a result? If the budget were balanced before the tax cut, what is the surplus or deficit after the tax cut?
(d) Suppose that the budget is balanced under the initial conditions in (a) above and that government wishes to keep it that way. Compare the following policies. Do any of them improve "welfare" (i.e., the social good) more than the others? In particular, consider how the policies affect consumption, GDP, and the government's budget deficit.

(i) An increase of government expenditure of 100 accompanied by a decrease in transfer payments of 100, holding T constant. Find the new tr (assuming tr_0 constant), the new t, and the change in Y.
(ii) An increase of government expenditure of 100 accompanied by a increase of taxes of 100, holding TR constant. Find the new t, the new tr (assuming tr_0 constant), and the change in Y.
(iii) A decrease in taxes of 100 accompanied by a decrease in transfer payments of 100. Find the new tr (assuming tr_0 constant), the new t and the change in Y.

Problem 12.7. Consider an economy in which aggregate demand is described by the following equations:

$$C = 200 + 0.9(Y + TR - T)$$
$$I = 200 - 25rr$$

$$T = tY.$$

(Note that the real rate of interest (*rr*) is measured in percentage points, not as a natural fraction.) Initially, $G = 400$, $TR = 100$, the market rate of interest (r) is 6 percent, and the expected rate of inflation ($\hat{p}^e$) is 2 percent.

(a) Assuming that the budget is balanced, what are the values of aggregate demand and the tax rate?
(b) All other things equal, what is the effect of an increase of 50 in transfer payments on aggregate demand and the government deficit?
(c) What would the effect be on demand of an increase of 50 in transfer payments if the tax rates were adjusted to keep the budget balanced? What tax rate would be necessary to achieve a balanced budget?
(d) All other things equal, what would be the effect on aggregate demand of a 1 percentage point increase in market interest rates?
(e) All other things equal, what would be the effect on aggregate demand of a 1 percentage point increase in the expected rate of inflation?

Problem 12.8. Consider an economy in which aggregate demand is described by the following equations:

$$C = 100 + 0.9(Y + TR - T)$$
$$I = 300 - 20rr$$
$$G = 400$$
$$TR = 200$$
$$T = tY$$
$$NEX = 100$$

(Note that the real rate of interest (*rr*) is measured in percentage points, not as a natural fraction.)

(a) Initially if $rr = 6\%$ and $t = 0.14285$ (i.e., 14.285%), what is Y? If you have calculated this correctly, the budget will be balanced.
(b) Starting from the situation in (a), what would be the effect on Y of an increase of 100 in transfer payments? How would the government budget deficit be affected?
(c) Starting from the situation in (a), what would be the effect on Y of an decrease of 100 in G while keeping the government budget balanced? What tax rate (t) would the government have to set to achieve this?

Problem 12.9. For the same economy as described in Problem 12.8:

(a) Write down the equation for the IS curve. Sketch the curve.
(b) Starting from the situation in Problem 12.8(a) show that the IS curve implies that Y is what you calculated in Problem 12.8(a).
(c) What would be the effect on Y and the budget deficit of an action by the monetary authorities that cut rr by one percentage point?

(d) Again, starting from the situation in Problem 12.8(a), what would be the effect of a cut in the tax rate to $t = 0.12$. Calculate the value of Y, the budget deficit, and sketch the shift in the IS curve.

Problem 12.10. Any outflow from the domestic private sector that rises in the boom and falls in the slump might act as an automatic stabilizer. As well as taxes, candidates include transfer payments, imports, and inventory investment.

(a) To get an idea of which of these act as automatic stabilizers, express each as percentage of potential GDP (i.e., form scaled variables $\tilde{T}, \widetilde{TR}, \tilde{M}, \widetilde{InvI}$). This removes the trends and, since potential output is acyclical, does not itself contribute to the cyclicality. Plot each series against the NBER cycle dates (or use any other reasonable technique) to determine its cyclicality. Do the series show the right cyclicality to be automatic stabilizers?

(b) To get an idea of the size of the stabilization effect, calculate $\tilde{Y}$; calculate the standard deviation of each it and each of those series that you identified as automatic stabilizers in (a); multiply each standard deviation (other than that of $\tilde{Y}$) by the consumption multiplier you computed in Problem 12.3 (or by 0.90, the value in equation (12.17) if you did not do Problem 12.3); express your result as a percentage of $\tilde{Y}$. Your value is an estimate of the upper bound to the additional fluctuations that would occur in $\tilde{Y}$, but for the action of the automatic stabilizer. Explain why this is an appropriate measure and why it is only an upper bound?

(c) Assess the effectiveness of the automatic stabilizers in light of your investigation.

Problem 12.11. Using the illustrative model in the text (see section 12.3.2, case 7), work out an numerical example and a diagram to show that an increase in the marginal tax rate results in a leftward movement of the IS curve.

Problem 12.12. How to the following affect the IS curve?

(a) A decrease in exports;
(b) A decrease in imports;
(c) An increase in the marginal propensity to import (i.e., the rate at which imports increase with an increase in GDP);
(d) An increase in investment risk;
(e) An increase in the savings rate;
(f) A decrease in the expected returns to investment;
(g) An increase in payments of interest on the government debt.

Problem 12.13. Using the IS-LM model and assuming that the economy is at less than full employment, how would each of the cases in Problem 12.12 affect aggregate demand and the real interest rate?

Problem 12.14. Using the IS-LM model and assuming that the economy is at less than full employment, how would the following affect aggregate demand and the real interest rate?

(a) A cut in the money supply;
(b) An increase in the speculative demand for money;
(c) The substitution of ATM cards for cash and check transactions.

Problem 12.15. Using the IS-LM model and assuming that the economy is at full employment, how would a 10 percent increase in the supply of money affect the price level and the real rate of interest? Be specific about the quantitative effects.