9 Common Fallacies Show why the following statements are incorrect: (*a*) The average consumer has never heard of an indifference curve or a budget line. Hence it cannot be correct to think of consumers choosing the point on the budget line which is tangent to the highest possible indifference curve. (*b*) If inflation leads to a doubling of all incomes and prices the budget line will shift and consumers will reduce quantities of each good demanded. (*c*) If in (*b*) consumers demand the same quantities as before, this proves that income effects can be neglected.

6

Output Supply by Firms: Revenue and Cost

Having analysed demand in the last two chapters, we turn now to supply. How do firms decide how much to produce and offer for sale? Can a single theory of supply describe the behaviour of a wide range of different producers, from giant companies such as ICI and Shell to the self-employed ice cream vendor with a van?

For each possible output level a firm will wish to know the answer to two questions: how much will it *cost* to produce this output and how much *revenue* will be earned by selling it. For each output level, production costs depend on technology that determines how many inputs are needed to produce this output, and on input prices that determine what the firm will have to pay for these inputs. The revenue obtained from selling output depends on the demand curve faced by the firm. The demand curve determines the price for which any given output quantity can be sold and hence the revenue that the firm will earn. Figure 6-1 emphasizes that it is the interaction of costs and revenues that determines how much output firms wish to supply.

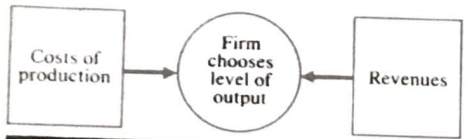
Profits are the excess of revenues over costs. The key to the theory of supply is the assumption that all firms have the same objective: to make as much profit as possible. By examining how revenues and costs change with the level of output produced and sold, the firm can select the output level which maximizes its profits. To understand how firms make output decisions we must therefore analyse the determination of revenues and costs.

We introduce two essential concepts in the theory of supply, *marginal cost* and *marginal revenue*. Although later chapters give a more detailed analysis, these concepts form the framework for the economist's approach to supply. Finally, because the assumption of profit maximization forms the cornerstone of this approach, we discuss the plausibility of this assumption and examine alternative views of what firms' aims might be.

6-1 BUSINESS ORGANIZATION

In the UK businesses are self-employed sole traders, partnerships, or companies. Table 6-1 shows that in 1978, the last year a detailed breakdown was published, there were over 2.5 million firms, the vast majority of which were sole traders whose average profit was around £2700. (Remember that, because of inflation, this would be worth considerably more at today's prices.) The average profits of partnerships were nearly three times larger, and the average profits of companies much larger still. These average figures conceal wide disparities.

FIGURE 6-1 THE THEORY OF SUPPLY. Firms' decisions about how much to produce and supply depend both on the costs of production and on the revenues they receive from selling the output. This is the essence of the theory of supply. For the rest of this chapter and in the next chapter we fill in the details of this picture.



For example, although average company profits were £30 850 in 1978, some of the largest companies made profits of tens or even hundreds of million pounds.

A *sole trader* is a business owned by a single individual who is fully entitled to the income or revenue of the business and is fully responsible for any losses the business suffers. You might open a health food shop, renting the premises and paying someone to stand at the till. Although you can keep the profits, if the business makes losses that you cannot meet you will have to declare bankruptcy. Your remaining assets, including personal assets such as your house, will then be sold and the money shared out between your creditors.

However, your health food shop may prosper. You need money to expand, to buy bigger stocks, better premises, a delivery van, and office furniture. To raise all this money, you may decide to go into partnership with some other people.

TABLE 6-1
BUSINESS FIRMS IN THE UK IN 1978

	NUMBER OF FIRMS (thousands)	AVERAGE PROFIT (£)
Sole traders	1675	2 700
Partnerships	425	7 900
Companies	451	30 850

Source: Inland Revenue Statistics, HMSO, 1982.

A *partnership* is a business arrangement in which two or more people jointly own a business, sharing the profits and being jointly responsible for any losses. Not all the partners need to be active. Some may have put up some money for a share of the profits but take no active part in running the business. Some large partnerships, such as famous law and accounting firms, may have over a hundred partners, usually all taking an active interest in the business.

Nevertheless, partnerships still have *unlimited liability*. In the last resort, the owners' personal assets must be sold to cover losses that cannot otherwise be met. This is one reason why firms where trust is involved – for example, firms of solicitors or accountants – are partnerships. It is a signal to the customers that the people running the business are willing to put their own personal wealth behind the firm's obligations.

Any business needs some financial capital, money to start the business and finance its growth, paying for stocks, machinery, or advertising before the corresponding revenue is earned. Firms of lawyers, accountants, or doctors, businesses that rely primarily on human expertise, need relatively little money for such purposes. The necessary funds can be raised from the partners and, possibly, by a loan from the bank. Businesses that require large initial expenditure on machinery, or are growing very rapidly, may need much larger amounts of initial funds. Because of legal complications, it may not make sense to take on an enormous number of partners. Instead, it makes sense to form a company.

A *company* is an organization legally allowed to produce and trade. Unlike a partnership, it has a legal existence distinct from that of its owners. Ownership is divided among shareholders. The original shareholders are the people who started the business, but now they have sold shares of the profits to outsiders. By selling these entitlements to share in the profits, the business has been able to raise new funds.

For *public companies* these shares can be resold on the *stock exchange* to anyone prepared to pay the going price. Trading on the stock exchange, reported in most daily newspapers, is primarily the sale and resale of existing shares in public companies. However, even the largest company occasionally needs to issue additional new shares to raise money for especially large projects.

To buy into a company, a shareholder must purchase shares on the stock exchange at the equilibrium share price, which just balances buyers and sellers of the company's shares on that particular day. In return for this initial outlay, shareholders earn a return in two ways. First, the company makes regular *dividend* payments, paying out to shareholders that part of the profits that the firm does not wish to re-invest in the business. Second, the shareholders may make *capital gains* or losses). If you buy ICI shares for £300 each and then everyone decides ICI profits and dividends will be unexpectedly high, you may be able to resell the shares for £350, making a capital gain of £50 per share on the transaction.

The shareholders of a company have *limited liability*. The most they can lose is the money they originally spent buying shares. Unlike sole traders and partners, shareholders cannot be forced to sell their personal possessions when the business cannot pay. At worst, the shares merely become worthless.

Companies are run by boards of directors. The board of directors makes decisions about how the firm is run but must submit an annual report to the shareholders. At the annual meeting the shareholders can vote to sack the directors, each shareholder having as many votes as the number of shares owned.

Companies are the main form of organization of big businesses.

6-2 REVENUES, COSTS, AND PROFITS

A firm's *revenue* is the amount it earns by selling goods or services in a given period such as a year. The firm's *costs* are the expenses incurred in producing goods or services during the period. *Profits* are the excess of revenues over costs.

Thus we can write

Profits = revenues – cost (1)

Although these ideas are simple, in practice the calculation of revenues, costs, and profits for a large business is complicated. Otherwise we would not need so many accountants. We begin with a simple example.

Rent-a-Person is a firm that hires people whom it then rents out to other firms that need temporary workers. Rent-a-Person charges £10 per hour per worker but pays its workers only £7 per hour. During 1987 it rented 100 000 hours of labour. Business expenses, including leasing an office, buying advertising space, and paying telephone bills, came to £200 000. Figure 6-2 shows the *income statement* or *profit-and-loss account* for 1987. Profits or net income before taxes were £100 000. Taxes to central government (corporation tax) plus taxes to local government (rates assessed on some of the property the firm owned) came to £25 000. Rent-a-Person's after-tax profits in 1987 were £75 000.

Now we can discuss some of the complications in calculating profits.

Outstanding Bills

People do not always pay their bills immediately. At the end of 1987, Rent-a-Person has not been paid for all the workers it hired out during the year. On the other hand, it has not paid its telephone bill for December. From an economic viewpoint, the right definition of revenues and costs relates to the activities carried out during the year whether or not payments have yet been made.

This distinction between economic revenues and costs and actual receipts and payments raises the important concept of cash flow.

A firm's *cash flow* is the net amount of money actually received during the period.

Profitable firms may still have a poor cash flow, for example when customers are slow to pay their bills.

Part of the problem of running a business is that cash flow at the beginning is bound to be slow. Set up costs must be incurred before revenues

FIGURE 6-2
Rent-a-Person
Income Statement
For the Year Ending 31 December 1987

Revenue		
(100 000 hours rented out at £10 per hour)		£1 000 000
Deduct expenses (costs)		
Wages paid to people rented out	£700 000	
Advertising	50 000	
Office rent	50 000	
Wages for office workers	80 000	
Other office expenses	20 000	
		900 000
Net income (profits) before taxes		£100 000
Taxes paid		25 000
Net income (profits) after taxes		£75 000

start to flow in. That is why firms need financial capital to start the business. If the business prospers, revenues will build up and eventually there will be a healthy cash inflow.

Capital and Depreciation

Physical capital is the machinery, equipment, and buildings used in production.

Rent-a-Person owns little physical capital. Instead, it rents office space, typewriters, and desks. In practice, businesses frequently buy physical capital. Economists use 'capital' to denote goods not entirely used up in the production process during the period. Buildings and lorries are capital because they can be used again in the next year. Electricity is not a capital good because it is used up entirely during the period. Economists also use the terms 'durable goods' or 'physical assets' to describe capital goods.

How should the cost of a capital good such as typewriters be treated in calculating profits and costs? The essential idea is that it is the cost of *using* rather than *buying* a piece of capital equipment that should be treated as part of the firm's costs within the year. If Rent-a-Person leases all its capital equipment, its costs include merely the rentals paid in leasing capital goods.

Suppose however that Rent-a-Person buys eight typewriters at the beginning of the year for £1000 each. It should *not count* £8000 as the cost of typewriters in calculating costs and profits for that year. Rather, the cost should be calculated as the reduction in the value of the typewriters over the year. Suppose the wear-and-tear on the typewriters over the year has reduced their value from £1000 to £700 each. The economic cost of the use of eight typewriters over the year is £2400 (8 × £300). This amount of depreciation is the cost during the year.[1]

Depreciation is the loss in value resulting from the use of machinery during the period.

The cost during the period of using a capital good is the depreciation or loss of value of that good, not its purchase price.

The existence of depreciation again leads to a difference between economic profits and cash flow. When a capital good is first purchased there is a large cash outflow, much larger than the depreciation cost of using the good during the first year. Profits may be high but cash flow low. However, in subsequent years the firm makes no further cash outlay, having already paid for the capital goods, but must still calculate depreciation as an economic cost since the resale value of goods is reduced still further. Cash flow will now be higher than economic profit.

The consequence of treating depreciation rather than purchase price as the true economic cost is thus to spread the initial cost over the life of the capital good; but that is not the reason for undertaking the calculation in this way. Rent-a-Person could always have sold its typewriters for £5600 after one year, restricting its costs to £2400. The fact that the firm chose to keep them for re-use in the next year indicates that the latter strategy is even more profitable. Hence the true economic cost of *using* the typewriters in the first year can be at most £2400.

[1] There is a *second* economic cost – the interest payments on the money used to buy the typewriters – which we discuss shortly.

Inventories

Inventories are goods held in stock by the firm for future sales.

If production were instantaneous, firms could produce to meet orders as they arose. In fact, production takes time. Firms will hold inventories to meet future demand.

Suppose at the beginning of 1987, the Rover Group has a stock of 100 000 cars completed and available for sale. During the year it produces 1 million new cars and sells 950 000. By the end of the year its inventories of finished cars have risen to 150 000. How does this complicate the profit calculation? Revenues accrue from the sale of 950 000 cars. Should costs be based on sales of 950 000 cars or the 1 million actually made?

The answer is that costs should relate to the 950 000 cars actually sold. The 50 000 cars added to stocks are like capital the firm made for itself, available for sale in the following period. There was a cash outflow to pay for the manufacture of 1 million cars but part of this cash outflow was for the purchase of inventories which will provide cash revenue the following year without requiring any cash outlay on production.

Borrowing

Firms usually borrow to finance their set-up and expansion costs, buying capital goods, solicitors' fees for the paperwork in registering the company, and so on. There is interest to be paid on the money borrowed. This interest is part of the cost of doing business and should be counted as part of the costs.

The Balance Sheet

The income statement or profit-and-loss account of Figure 6-2 tells us about the flow of money during a given year. We also paint a picture of the position the firm has reached as a result of all its past trading operations. The *balance sheet*, a sheet listing the assets the firm owns and the liabilities for which it is responsible, gives such a picture at a point in time, for example at the year end.

Figure 6-3 is a balance sheet for Snark International on 31 December 1987.

Assets are what the firms owns.

The assets are shown on the left. Snark has some cash in the bank, is owed money by customers which is entered as 'accounts receivable', and has large inventories in its warehouses. It owns a factory which originally cost £250 000 but is now worth only £200 000 because of depreciation. Its other equipment, listed together, has also depreciated and is now worth £180 000. The total value of Snark assets is £590 000.

Liabilities are what the firm owes.

The liabilities are shown on the right. They include unpaid bills and salaries, the mortgage on the factory, and a bank loan for shorter-term cash needs. The total value of debts is £350 000. The *net worth* of Snark International is £240 000, the excess of its assets over its liabilities.

We have shown the net worth on the liabilities side. Because the firm is owned by the shareholders, the net worth is really owed to them; it is a liability of the firm to the shareholders.

You wish to make a take-over bid for Snark International. Should you offer £240 000, the net worth of the company? Probably not. Snark International is a live company with good pros-

FIGURE 6-3
Snark International
Balance Sheet
31 December 1987

ASSETS		LIABILITIES	
Cash	£40 000	Accounts payable	£90 000
Accounts receivable	70 000	Salaries payable	50 000
Inventories	100 000	Mortgage from insurance company	150 000
Factory building (original value £250 000)	200 000	Bank loan	60 000
Other equipment (original value £300 000)	180 000		350 000
		Net worth	240 000
	590 000		590 000

pects for future growth and a proven record. You are bidding not merely for its physical and financial assets minus liabilities but also for the firm as a going concern. You will also get its reputation, customer loyalty and a host of intangibles which economists call *goodwill*. If Snark is a sound company it will be worth bidding more than £240 000.

Alternatively, you may feel that Snark's accountants have undervalued the resale value of its assets. If you can buy the company for close to £240 000 you might make a profit selling off the separate pieces of equipment and buildings, a practice known as 'asset-stripping'.

Earnings

Finally, we must consider what the firm does with its profits after taxes. It can pay them out to shareholders as dividends, or keep them in the firm as retained earnings.

> *Retained earnings* are the part of after-tax profits that is ploughed back into the business rather than paid out to shareholders as dividends.

Retained earnings affect the balance sheet. If they are kept as cash or used to purchase new equipment, they increase the asset side of the balance sheet. Alternatively, they may be used to reduce the firm's liabilities, for example by repaying the bank loan. Either way, the firm's net worth is increased.

Opportunity Cost and Accounting Costs

The income statement and the balance sheet of a company provide a useful guide to how that company is doing. We have already hinted that economists and accountants do not always take the same view of costs and profits. Whereas the accountant is chiefly interested in describing the actual receipts and payments of a company, the economist is chiefly interested in the role of costs and profits as determinants of the firm's supply decision, the allocation of resources to particular activities. Accounting methods can be seriously misleading in two ways.

Economists identify the cost of using a resource not as the payment actually made but as its opportunity cost.

> *Opportunity cost* is the amount lost by not using the resource (labour or capital) in its best alternative use.

To show that this is the right measure of costs,

given the questions economists wish to study, we give two examples.

Any persons working in their own businesses should take into account the cost of their own labour time spent in the business. A self-employed sole trader might draw up an income statement such as Figure 6-2, find that profits were £20 000 per annum, and conclude that this business was a good thing. But this conclusion neglects the opportunity cost of the individual's labour, the money that could have been earned by working elsewhere. If that individual could have earned a salary of £25 000 working for someone else, being self-employed is actually *losing* the person £5000 per annum even though the business is making an accounting profit of £20 000. If we wish to understand the incentives that the market provides to guide people towards particular occupations, we must use the economic concept of opportunity cost, not the accounting concept of actual payments. Including the opportunity cost of £25 000 in the income statement would quickly convince the individual that the business was not such a good idea.

The second place where opportunity cost must be counted is with respect to capital. Somebody has put up the money to start the business. In calculating accounting profits, no cost is attached to the use of owned (as opposed to borrowed) financial capital. This financial capital could have been used elsewhere, in an interest-bearing bank account or perhaps to buy shares in a different company. The opportunity cost of that financial capital is included in the *economic* costs of the business but not its accounting costs. For example, if the owners could have earned a return of 10 per cent elsewhere, the opportunity cost of their funds is 10 per cent times the money they put up. If, after deducting this cost, the business still makes a profit, economists call this 'supernormal profit'.

> *Supernormal profit* is the profit over and above the return which the owners could have earned by lending their money elsewhere at the market rate of interest.

Supernormal profits provide the true economic indicator of how well the owners are doing by tying up their funds in the business. Supernormal profits, not accounting profits, are the measure that will explain the incentive to shift resources into or out of a business.

These are the two most important adjustments between accounting and economic notions of costs and profits. In other cases there may be minor differences – for example, since it is hard to calculate the resale value of a second-hand factory, economic and accounting approaches to depreciation may vary slightly. In many cases the two approaches are the same – for example, the wages paid by farmers to students for help in picking crops are not only an accounting cost but an economic cost. Without making these payments, farmers would not have been able to attract temporary student labour resources to the activity of crop picking.

Figure 6-4 summarizes the two most important adjustments that must be made to accounting costs and profits to get economic measures of costs and profits.

6-3 FIRMS AND PROFIT MAXIMIZATION

Firms are in business to make money. Economists assume that firms make supply and output decisions so as to make as much money as possible, in other words to *maximize profits*.

Some economists and business executives question the assumption that firms have the sole aim of maximizing profits. For example, in the last section we described a self-employed individual making £20 000 per annum who could have made £25 000 per annum in a different job. Individuals who like to be their own boss may happily exchange the extra £5000 for the additional independence. Such a business is maximizing not the net income but the total satisfaction of its owner.

Ownership and Control

A more significant reason to question the assumption of profit maximization is that large firms are not run by their owners. A large company is run

FIGURE 6-4 ACCOUNTING AND OPPORTUNITY COSTS: TWO IMPORTANT ADJUSTMENTS.
Economic costs represents the opportunity costs of resources used in production. Accounting costs include most economic costs but are likely to omit costs of the owner's time and the opportunity cost of financial capital used in the firm. Economic (supernormal) profit deducts the right measure of economic costs from revenues.

ACCOUNTING: INCOME STATEMENT		
Revenues		£80 000
Costs		50 000
Accounting profit		£30 000

OPPORTUNITY COSTS: INCOME STATEMENT		
Revenues		£80 000
Costs:		
Accounting costs	£50 000	
Cost of owner's time	25 000	
Opportunity cost of financial capital (£30 000) used in firm, at 10%	3 000	78 000
Economic profit (supernormal)		£ 2 000

by a salaried board of directors and by the managers this board appoints. Although at the annual meeting the shareholders have the opportunity to dismiss the board, in practice this happens rarely. The directors are the experts with the information; it is hard for the shareholders, even in bad times, to be sure that different directors would raise the profitability of the company.

Economists call this a separation of ownership and control. Although the shareholders clearly want the maximum possible profit, the directors who actually make the decisions have the opportunity to pursue different objectives. Do the managers and directors have an incentive to act other than in the interests of the shareholders?

Managers' salaries are usually higher the larger is the firm. Some economists have argued that this leads managers to aim for size and growth rath than the maximum possible profit. For examp such managers might spend large sums on adve tising even though this secured only a relative small addition to total sales.

Nevertheless, there are two reasons why th assumption of profit maximization is a good plac from which to begin. Even if the shareholde cannot recognize that profits are lower than the might be, other firms with experience in th industry may catch on faster. If profits are low share prices will be low. By mounting a take-ove another company can buy the shares cheaply, sack the existing managers, restore profit-maximizing policies, and make a handsome capital gain as the share prices then rise once the stock market perceives the improvement in profits.

Alternatively, being aware of the opportunity for managerial discretion, shareholders may try to ensure that the interests of the managers and the shareholders coincide. By giving senior managers a quantity of shares that is small relative to the total number of shares but large relative to managerial salaries, shareholders can try to ensure that senior managers care about profits as much as other shareholders do.

For these reasons, the assumption that firms try to maximize profits is more robust than might first be imagined. We now use this assumption to develop the theory of supply.

6-4 THE FIRM'S PRODUCTION DECISIONS: AN OVERVIEW

We begin by focusing on how much output should be produced. Many details are left for later chapters, but the really important ideas of marginal cost and marginal revenue are introduced here.

Imagine a firm that makes snarks. Of the many ways to make snarks, some use a lot of labour and few machines, others a lot of machines but little labour. Not only does the firm know the different techniques for making snarks, it also knows the wage rate for a skilled snark lathe operator and the rental on a snark lathe. The firm also knows its demand curve – how much it would earn by selling different quantities of snarks at each possible price.

The objective is to maximize profits by choosing the best level of output to produce. Changing the output level will affect both the costs of production and the revenues obtained from sales. We now show how production costs and demand conditions interact to determine the level of output chosen by a profit-maximizing firm.

Cost Minimization

Any firm that is maximizing profits will certainly want to be producing its chosen output level at the minimum possible cost. Otherwise, by producing the same output level at lower cost it could increase profits. Thus a profit-maximizing firm must be producing its output at minimum cost.

The Total Cost Curve

Knowing the available production methods and the costs of hiring labour and machinery, the firm's managers can calculate the lowest cost at which each level of output can be produced. To make a few snarks per annum it is probably cheapest to use some workers but hardly any machinery. To make more snarks, it probably makes sense to use more machinery per worker.

Table 6-2 shows the minimum costs at which each output level can be produced. The firm incurs a cost of £10 even when no output is produced.[2] This cost includes the expenses of being in business at all – running an office, renting a telephone, and so on. Thereafter, costs rise with the level of production. The costs shown in the table include the opportunity costs of all resources used in production. Total costs of production are higher the more is produced, but costs need to rise smoothly as the level of output increases. At intermediate levels of output, such as 4 or 5 units per week, costs rise quite slowly as output rises. At high levels of output, such as 9 units per week, costs rise sharply as output increases. For example, at high levels of output the firm may have to pay the workers extra money to work at weekends.

[2] Imagine the numbers in Table 6-2 are in thousands. To keep things simpler, we have left out the thousands.

TABLE 6-2
TOTAL COSTS OF PRODUCTION

OUTPUT (goods produced/week)	TOTAL COSTS (£/week)
0	10
1	25
2	36
3	44
4	51
5	59
6	69
7	81
8	95
9	111
10	129

Figure 6-5 shows total costs of production for each output level in Table 6-2.

Total Revenue

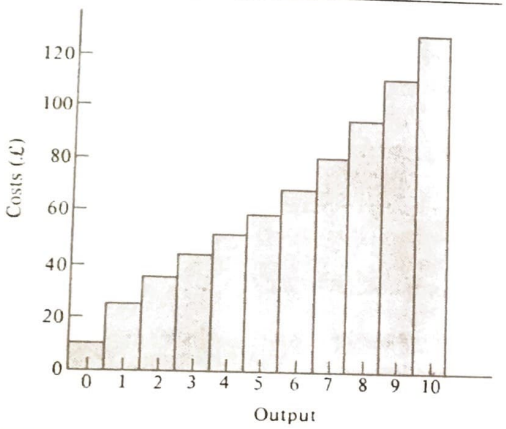
Information on costs is not sufficient to assess profits. The firm must also think about its revenue, which depends on the demand for its product.

Table 6-3 shows the demand curve facing the firm. At a price of £21 it can sell only one snark. The lower the price, the more snarks it can sell: its demand curve slopes down. Given the prices at which each quantity can be sold, in Table 6-3 we calculate the firm's total revenue from selling different quantities of snarks per week. Total revenue is just price times quantity, as shown in the third column.

The fourth column shows the total cost of producing each output level. The last column shows weekly profits, the difference between revenues and costs. At low levels of output, profits are negative. At the highest level of output, 10 units per week, profits are again negative. At intermediate levels of output, the firm is making profits.

The highest level of profits is £27 per week and the corresponding output level is 6 snarks per week. To maximize profits the firm produces 6 snarks per week. At £16 each, this brings in £96 in total revenue. Costs of production, properly

FIGURE 6-5 TOTAL COSTS OF PRODUCTION. The chart shows the minimum cost of producing each level of output. The level of cost depends both on the technology available to the firm and on the price of inputs including labour. At low levels of production, costs rise quite fast. Then, when 4 or 5 units of the good are being produced, costs rise more slowly. As output continues to rise, costs begin to increase more rapidly again.



calculated to include the opportunity cost of all resources used, are £69 per week, leaving a profit of £27 per week. The level of output and profits chosen by the firm are shown in blue in Table 6-3.

Maximizing profit is *not* the same as maximizing revenue. By selling 10 snarks a week the firm could earn £120, but its costs would be £129. As we shall see in the next section, making the last few snarks is very expensive and brings in very little extra revenue. It is actually much more profitable to make a few less.

To sum up, the firm calculates the level of profit associated with each possible output level. To do this, it must know both the revenue received at each output level and the cost of producing each output level. From revenues and costs it calculates profit at each output level, and selects the level of output that maximizes total economic profit.

6-5 MARGINAL COST AND MARGINAL REVENUE

It is helpful to view the same problem from a different angle. At each output level we now ask whether the firm should increase output still further. Suppose the firm produces 3 snarks and considers moving to 4 snarks. From Table 6-3, we reproduce the relevant cost and revenue data in Table 6-4. Increasing output from 3 to 4 snarks will raise total cost from £44 to £51, a £7 increase in total cost. Revenue will increase from £57 to £72, an increase of £15 in total revenue. Increasing output from 3 to 4 snarks adds more to revenue than costs. Profit will rise by £8 (£15 of extra revenue less £7 of extra costs). Having decided that it is profitable to increase production from 3 to 4 snarks, we can repeat the exercise, asking whether it is profitable to move from 4 to 5, and if so whether it is profitable to move from 5 to 6, and so on.

This approach – examining how the production of 1 more unit of output will affect profits – focuses on the marginal cost and marginal revenue of producing one more unit.

> *Marginal cost* is the increase in total cost when output is increased by 1 unit. *Marginal revenue* is the increase in total revenue when output is increased by 1 unit.

The crucial point is that, so long as marginal revenue exceeds marginal costs, the firm should increase its level of output. Why? Because producing and selling 1 more unit is adding more to total revenue than to total cost, thereby increasing total profit.

Conversely, if marginal cost exceeds marginal revenue, the extra unit of output reduces total profit. Thus we can use marginal cost and marginal revenue to calculate the output level that maximizes profit. So long as marginal revenue exceeds marginal cost, keep increasing output. As soon as marginal revenue falls short of marginal cost, stop increasing output. To clarify this argument, we look more closely at marginal revenue and marginal cost.

TABLE 6-3
REVENUES, COSTS, AND PROFITS

(1) OUTPUT (goods produced/week)	(2) PRICE RECEIVED PER UNIT (£)	(3) TOTAL REVENUE (PRICE × OUTPUT) (£/week)	(4) TOTAL COSTS (FROM TABLE 6-2) (£/week)	(5) PROFITS (TOTAL REVENUE MINUS TOTAL COSTS)
0	—	0	10	−10
1	21	21	25	− 4
2	20	40	36	4
3	19	57	44	13
4	18	72	51	21
5	17	85	59	26
6	16	96	69	27
7	15	105	81	24
8	14	112	95	17
9	13	117	111	6
10	12	120	129	− 9

Marginal Cost

Table 6-5 uses Table 6-2 to calculate the marginal cost of producing each extra unit of output. Increasing production from 0 to 1 snark increases total costs from £10 to £25. The marginal cost of the first unit is £15. In Table 6-5 we show the marginal cost on a line between 0 and 1 snark to make clear that it is the cost of increasing output from 0 to 1 snark. All other marginal costs in the table are calculated in the same way. For example, the marginal cost of increasing output from 6 to 7 snarks is £12 (£81 − £69).

The marginal cost of increasing output by 1 unit at each output level is shown in Figure 6-6(b), taken directly from Table 6-5. But it can also be calculated from Figure 6-6(a) taken from Figure 6-5. In Figure 6-6(a) we show the total cost of producing each output level. Marginal cost is the amount total cost rises when output is increased 1 unit. For example, going from 0 to 1 unit, total costs rise by £15, shown by the shaded area *ABCD*. The shaded area just shows the marginal cost of producing 1 more unit. Thus Figure 6-6(b) could be taken from Figure 6-6(a) as well as Table 6-5.

Either way, we see that marginal cost is high when output is low but also when output is high. Marginal cost is lowest for the production of the fourth unit, which adds only £7 to total costs.

Why do marginal costs start high, then fall, then rise again? The answer depends mainly on the different production techniques for making snarks. At low output levels, the firm is probably using simple techniques. As output rises more sophisticated machines can be used, which make extra units of output quite cheaply. Automated

TABLE 6-4
EFFECTS OF OUTPUT CHANGES ON COSTS AND REVENUES

OUTPUT (snarks/week)	TOTAL COST (£/week)	COST INCREASE (£/week)	TOTAL REVENUE (£/week)	REVENUE INCREASE (£/week)
3	44	7	57	15
4	51		72	

TABLE 6-5
TOTAL AND MARGINAL COSTS OF PRODUCTION

OUTPUT (snarks/week)	TOTAL COST (£/week)	MARGINAL COST (£/week)
0	10	
1	25	15
2	36	11
3	44	8
4	51	7
5	59	8
6	69	10
7	81	12
8	95	14
9	111	16
10	129	18

production lines make additional units cheaply but are prohibitively expensive at very small output levels. As output rises still further, the difficulties of managing a large firm begin to emerge. More office staff, who do not directly make snarks, are needed just to keep track of the business. Increased output is now expensive and marginal costs become higher.

The relation of marginal costs to output will vary from firm to firm. In a coal mine that is nearly worked out, marginal costs will rise steeply with additional output. In mass production industries that can be easily managed, marginal costs may have the pattern of Figure 6-7, starting out high but declining to a constant level. Higher levels of output are obtained merely by adding a second production line identical to the first. In the next chapter we examine evidence on the shape of cost curves in practice.

FIGURE 6-6 TOTAL AND MARGINAL COSTS OF PRODUCTION. Figure 6-6(a) reproduces Figure 6-5, showing total costs of production for each level of output. The shaded parts show the amount by which total costs go up when the level of output increases by 1 unit. Thus, total costs rise from 10 to 25 when output increases from 0 to 1 unit. This increase in total costs, at each level of output, is the marginal cost of increasing output by 1 unit. The marginal costs are shown in Figure 6-6(b), which uses a larger vertical scale. But it can be seen that the pattern of marginal costs shown in Figure 6-6(b) is precisely that shown in Figure 6-6(a): marginal costs are first high and decreasing; then they reach a minimum and start increasing again.

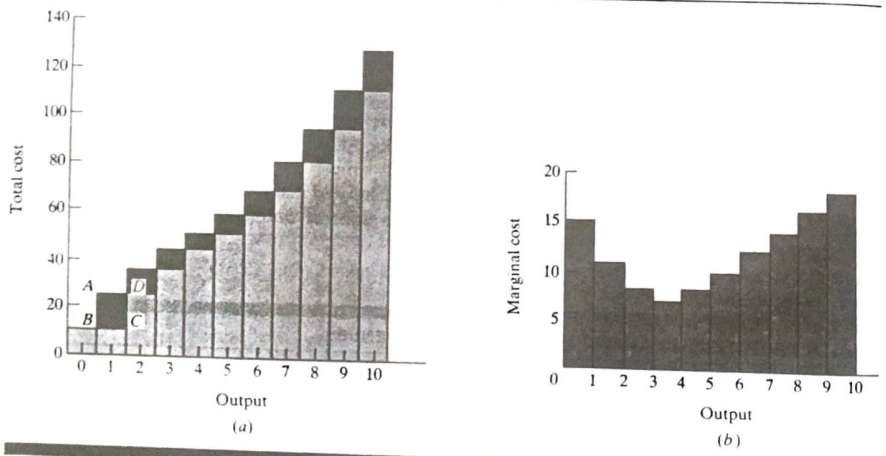
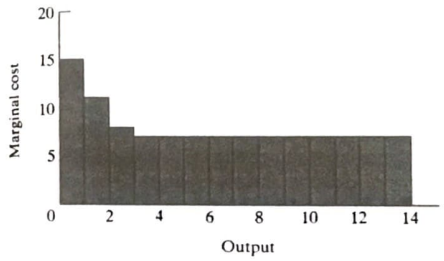


FIGURE 6-7 MARGINAL COSTS: A DIFFERENT PATTERN. In Figure 6-6, marginal costs first decline as output increases, but then begin to increase. A different possibility is that marginal costs at first decline, as it becomes possible to use more efficient methods of production with a larger output. But then marginal costs become constant: any further increases in output can be produced at the same addition to cost per unit (in the figure, the marginal cost is 7 for all units of output beyond 3). Which pattern actually applies in practice depends mainly on the techniques of production available to the firm. The pattern of marginal costs will vary from firm to firm and industry to industry.



Marginal Revenue

Table 6-6 shows the firm's marginal revenue, the increase in total revenue when an additional unit of output is sold. Taken directly from Table 6-3, Table 6-6 calculates marginal revenue as output is increased. Increasing output from 0 to 1 unit increases revenue from 0 to £21. Thus £21 is the marginal revenue of the first unit. Similarly, increasing output from 7 to 8 units increases revenue from £105 to £112 so marginal revenue is £7. Total and marginal revenue depend on the demand curve for the firm's product.

Marginal revenue is also shown in Figure 6-8 and is falling throughout. It can even become negative at high output levels. Suppose that 11 snarks per week can be sold only at a price of £10 each. Total revenue would then be £110 per week. Table 6-6 implies that the marginal revenue from moving from 10 to 11 snarks per week would be −£10 per week.

To understand how marginal revenue changes with output, we must keep track of two separate effects, which we show in the following equation

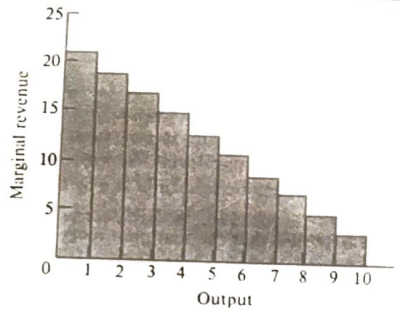
$$\begin{aligned}\text{Marginal revenue} &= \text{change in total revenue from selling 1 more unit of output} \\ &= (\text{additional revenue earned on last unit alone}) \\ &\quad - (\text{revenue lost by selling existing output at a lower price}) \qquad (2)\end{aligned}$$

Demand curves slope down. To sell more output, the price must be cut. Selling an additional unit of output at this lower price is the first component

TABLE 6-6
PRICE, TOTAL REVENUE, AND MARGINAL REVENUE

OUTPUT (snarks/week)	PRICE RECEIVED (£/snark)	TOTAL REVENUE (£/week)	MARGINAL REVENUE (£/week)
0	—	0	
1	21	21	21
2	20	40	19
3	19	57	17
4	18	72	15
5	17	85	13
6	16	96	11
7	15	105	9
8	14	112	7
9	13	117	5
10	12	120	3

FIGURE 6-8 MARGINAL REVENUE. Marginal revenue is the increase in the firm's revenue resulting from an increase in sales by one unit. In this diagram, the firm can sell more output only by reducing its price. Marginal revenue therefore declines as output rises.



of marginal revenue in equation (2). However, we must also take account of the fact that, in selling additional output, we bid down the price for which *all* previous units of output can be sold. This effect acts to reduce the additional revenue obtained from selling an extra unit of output.

In Table 6-6 the firm can sell 5 snarks at £17 each or 6 snarks at £16 each. Increasing output from 5 to 6, the firm earns £16 from selling the extra snark at £16, but it also loses £5 by cutting the price £1 on the 5 snarks it was already selling. Marginal revenue is thus £11.

Marginal revenue falls steadily for two reasons. First, because demand curves slope down, the last unit itself must be sold at a lower price the higher is output. Second, successive price reductions reduce the revenue earned from existing units of output. When the firm's demand curve slopes down, we have thus established two propositions.

(i) Marginal revenue falls as output rises.

(ii) Marginal revenue must be less than the price for which the last unit is sold. From this we must subtract the effect of lower prices on revenue earned from previous units of output.

The shape of the marginal revenue curve depends only on the shape of the firm's demand curve. Having studied the case where the demand curve slopes down, and having agreed in Chapter 5 to neglect the possibility that demand curves slope upwards, we must study only one further possibility. A small firm in a huge market may be able to sell as much output as it wishes without affecting the existing market price. A single wheat farmer's output may be insignificant relative to the total supply of wheat. Although the market demand curve for wheat slopes down, the individual farmer can sell wheat without bidding down the market price. For the individual farmer, the demand curve is horizontal at the equilibrium price of wheat. Each extra unit of output by the individual farmer earns the same marginal revenue, the wheat price itself. In terms of equation (2), the first term is constant and the second term, 'revenue lost on existing units', is zero. The marginal revenue schedule for such a firm is shown in Figure 6-9.

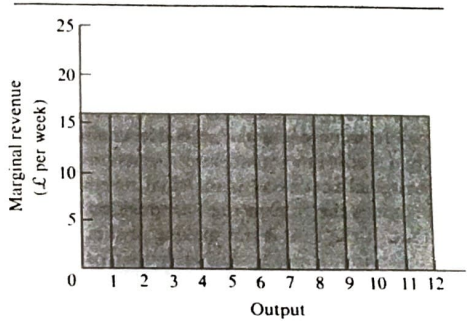
Using Marginal Revenue and Marginal Cost to Determine the Level of Output

Combining marginal cost and marginal revenue schedules from Table 6-5 and 6-6, Table 6-7 examines the level of output that maximizes the firm's profits. If marginal revenue exceeds marginal cost, a 1-unit increase in output will increase profits. The last column shows that this reasoning will lead the firm to produce at least 6 units of output.

Suppose the firm now considers increasing output from 6 to 7 units. Marginal revenue is £9 and marginal cost £12, so profits would fall by £3. Output should *not* be expanded to 7 units. Similar reasoning rules out expansion to any output level above 6 units. Wherever marginal cost exceeds marginal revenue the firm will save money by reducing output. It saves more by giving up the marginal cost that it loses by giving up the marginal revenue.

Hence, the firm should expand up to 6 units of output but no further. This is the output level that maximizes profits, as we know already from Table 6-3.

FIGURE 6-9 MARGINAL REVENUE: AN ALTERNATIVE PATTERN. In this figure the firm has the same marginal revenue however much it sells. This means it can sell goods at the existing market price without having to cut price. The existing price is £16. The firm will have constant marginal revenue if its output is very small relative to total amount sold in the market.



Total Cost and Revenue versus Marginal Cost and Revenue

Table 6-3, based on total cost and total revenue, and Table 6-7, based on marginal cost and revenue, are different ways of examining the same problem. Economists use marginal analysis more frequently because its suggests a useful way of thinking about the decision problem faced by firms or consumers. Is there a small change that could make the firm (or the consumer) better off? If so, the current position cannot be the best possible one and changes should be made.

Marginal analysis should be subjected to one very important check. It may miss an all-or-nothing choice. For example, suppose that marginal revenue exceeds marginal cost up to an output level of 6 units but thereafter marginal revenue is less than marginal cost. This suggests that 6 units should be produced. Producing 6 units is certainly better than producing any other output level. However, if the firm incurs large costs whether or not it produces (for example a vastly overpaid managing director), the profit earned from producing 6 units may not cover these fixed costs. Conditional on paying these fixed costs, an

TABLE 6-7
USING MARGINAL REVENUE AND MARGINAL COST TO DETERMINE OUTPUT

OUTPUT (units/wk)	MARGINAL REVENUE (£/wk)	MARGINAL COST (£/wk)	MARGINAL REVENUE MINUS MARGINAL COST (£/wk)	OUTPUT DECISION
0				
1	21	15	6	Increase
2	19	11	8	Increase
3	17	8	9	Increase
4	15	7	8	Increase
5	13	8	5	Increase
6	11	10	1	Increase
7	9	12	− 3	Decrease
8	7	14	− 7	Decrease
9	5	16	−11	Decrease
10	3	18	−15	Decrease

output level of 6 units is then the loss-minimizing output level. However, the firm might do better to shut down altogether. We examine this issue in greater detail in the next chapter.[3]

In summary, a profit-maximizing firm should expand output so long as marginal revenue exceeds marginal cost but should stop expansion as soon as marginal cost exceeds marginal revenue. This rule guides the firm to the best positive level of output. If the firm is not making profits even in this position, it might do better to close down altogether.

Marginal Cost and Marginal Revenue in Pictures

Figure 6-10 plots the marginal cost and marginal revenue schedules of Figures 6-6 and 6-8. The firm chooses the output level at which the marginal cost and marginal revenue schedules cross – when output is 6 units. At lower outputs, marginal revenue exceeds marginal cost and expansion is profitable. At higher outputs, marginal cost exceeds marginal revenue and contraction is profitable.

[3] Readers familiar with mathematical calculus will recognize that choosing output to set marginal revenue equal to marginal cost ensures that marginal profit equals zero. Although necessary for a local maximum of profits with respect to output, this condition does not guarantee positive profits.

FIGURE 6-10 MARGINAL COST AND MARGINAL REVENUE DETERMINE THE FIRM'S OUTPUT LEVEL. The figure shows both the marginal revenue and marginal cost schedules for the firm. The schedules intersect at the output level 6. That is the level of output at which the firm maximizes its profits, and it is therefore the level of output the firm produces. If the firm is making losses at the output level of 6, it might cut those losses by not producing at all.

Thus the firm maximizes profit by producing 6 units, where marginal cost equals marginal revenue, provided profits are positive at this output level. Any other output level necessarily yields lower profits. If profits are negative even at 6 units of output, the firm should close down if this will result in smaller losses.

6-6 MARGINAL COST AND MARGINAL REVENUE CURVES: $MC = MR$

Thus far we have assumed that the firm can produce only an integer number of goods, such as 0, 1 or 7, rather than a quantity such as 1.5 or 6.7. In most cases output is not confined to integer levels, for two reasons. First, for goods such as wheat or milk, there is no reason to think that only 1 bushel or 1 gallon units can be sold. The firm can sell in odd amounts. Second, even for goods such as cars, which are necessarily sold in whole units, the firm may be selling 75 cars every four weeks, or 18.75 cars per week. Thus it is convenient to imagine that firms can vary production levels and sales almost continuously.

If so, we can draw smooth marginal cost (MC) and marginal revenue (MR) schedules as in Figure 6-11. Again, profits are maximized where the two schedules cross, at the point E. The output level

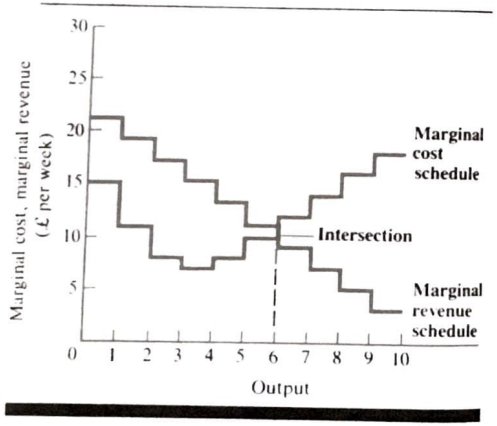
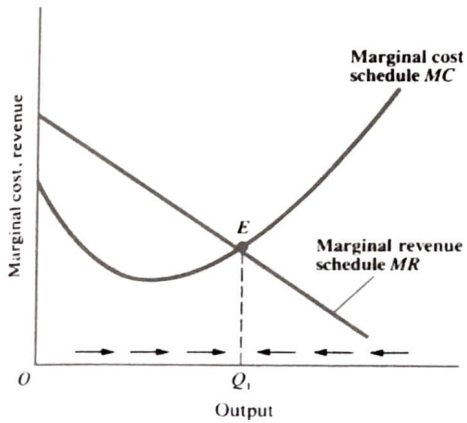


FIGURE 6-11 MARGINAL COST AND MARGINAL REVENUE DETERMINE THE FIRM'S OUTPUT LEVEL. The marginal cost and marginal revenue schedules or curves are shown changing smoothly here. The firm's optimal level of output is Q_1, the output level at which marginal revenue is equal to marginal cost. Anywhere to the left of Q_1, marginal revenue is larger than marginal cost and the firm should increase output, as shown by the arrows. Where output is greater than Q_1, marginal revenue is less than marginal cost and profits are increased by reducing output. This is shown by the arrows pointing to the left for output levels above Q_1. Once again, if the firm is losing money at Q_1 it has to check whether it might be better not to produce at all than to produce Q_1.



Q_1 maximizes profits (or minimizes losses). At smaller outputs, MR exceeds MC and expansion will increase profits (or reduce losses).

To the right of Q_1, MC exceeds MR. Expansion adds more to costs than revenue and contraction saves more in costs than it loses in revenue. Th profit incentive to increase output to the left Q_1 and to reduce output to the right of Q shown by the arrows in Figure 6–11. This incentiv guides the firm to choose the output level Q provided the firm should be in business at all.

At Q_1 marginal revenue is exactly equal marginal cost. This condition is sufficiently im portant to deserve a formal statement

$$MR = MC$$

at the profit-maximizing output level.

Table 6-8 summarizes the conditions for det mining the output level that maximizes profits.

The Effect of Changing Cost on Output

Suppose the firm agrees to pay a higher wage r or faces a price increase for a raw material. each output level, marginal costs will rise. Figur 6-12 illustrates this change by un upward shif from MC to MC'. Choosing output to set MC MR, the firm now produces at E'. Higher margi costs reduce profit-maximizing output from Q_1 t Q_2.

The Effect of a Shift in the Demand Curve on Output

Suppose that the firm's demand curve and margi revenue curve shift upwards. At each output lev price and marginal revenue are higher than befo In Figure 6-13 the MR curve shifts out to MR' inducing the firm to move from E to E''. High demand has led the firm to expand output fr Q_1 to Q_3.

TABLE 6-8 DETERMINING THE FIRM'S OUPUT LEVEL

MARGINAL CONDITION	DECISION	CHECK
$MR > MC$	Increase ouput	
$MR < MC$	Cut output	
$MR = MC$	Optimal output	If positive profits, produce this output level. If not, consider closing down for a while or going out of business altogether

FIGURE 6-12 AN INCREASE IN MARGINAL COST REDUCES OUTPUT. The marginal cost curve shifts up from *MC* to *MC'* as a result of an increase in the costs of using a factor of production: for instance, the wage may have risen. This upward shift moves the intersection of *MC* and *MR* curves from *E* to *E'* and results in a lower level of output. Output falls from Q_1 to Q_2. Thus, when the firm's costs rise, it decides to produce less.

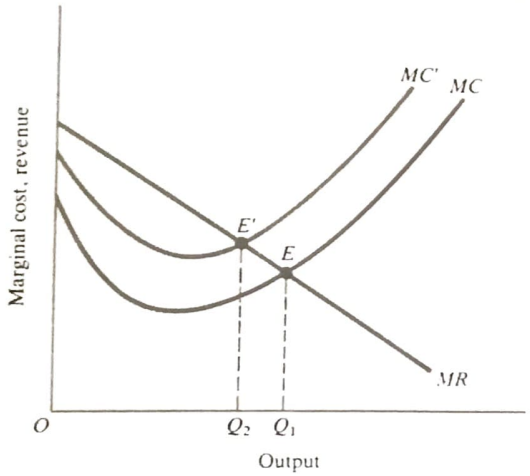
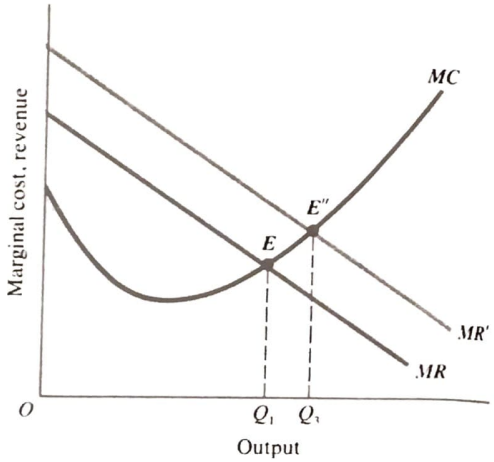


FIGURE 6-13 AN UPWARD SHIFT OF THE MARGINAL REVENUE CURVE INCREASES OUTPUT. When the *MR* curve shifts upward from *MR* to *MR'*, the intersection point between *MR* and *MC* curves shifts from *E* to *E''*. The firm's optimal level of output increases from Q_1 to Q_3. The upward shift in the marginal revenue curve could result, for instance, from an increase in the number of customers in the firm's market.



Do Firms Know Their Marginal Cost and Revenue Curves?

By now you may be wondering if firms in the real world know their marginal cost and marginal revenue curves, let alone go through some sophisticated calculations to make sure output is chosen to equate the two.

It is important to grasp that such thought experiments by firms are not necessary for the relevance of our model of supply. What we have shown is that if, by luck, hunch, or judgement, a manager succeeds in maximizing the firm's profits, then marginal cost and marginal revenue will *necessarily* be equal. What we have been doing is to develop a formal analysis by which we can keep track of the hunches of smart managers who get things right on average and survive in a tough business world.

In this chapter we have presented only an overview of cost and revenue conditions. Although later chapters will fill in the picture, we already have the basis for a theory of how much output firms choose to supply. First, firms choose the output level that will maximize profits. Second, this choice can be described using marginal cost and marginal revenue curves. Firms maximize profits by choosing the output level at which marginal cost equals marginal revenue.

SUMMARY

1 The theory of supply is the theory of how much output firms choose to produce.

2 There are three types of firm: self-employed 'sole traders', partnerships, and companies. Sole traders are the most numerous but are often very small. The large business firms are companies. In the UK the largest 1700 companies employ over 45 per cent of the labour force.

3 A company is an organization set up to conduct business. Companies are owned by their shareholders but run by managers responsible to the board of directors.

4 Shareholders have limited liability. Partners and sole traders have unlimited liability.

5 Revenue is what the firm earns from sales. Costs are the expenses incurred in producing and selling. Profits are the excess of revenue over costs.

6 Costs should include opportunity costs of all resources used in production. Opportunity cost is the amount an input could obtain in its next highest paying use. In particular, economic costs include the cost of the owner's time and effort in running a business. Economic costs also include the opportunity cost of financial capital used in the firm. Supernormal profit is the pure profit accruing to the owners after allowing for all these costs.

7 Firms are assumed to aim to maximize profits. Even though the firm is run by its managers, not its owners, profit maximization is a useful assumption in understanding the firm's behaviour. Firms that make losses cannot continue in business indefinitely.

8 In aiming to maximize profits, firms necessarily produce each output level as cheaply as possible. Profit maximization implies minimization of costs for each output level.

9 Firms choose the optimal output level to maximize total economic profits. This decision can be described equivalently by examining marginal cost and marginal revenue. Marginal cost is the increase in total cost when one more unit is produced. Marginal revenue is the corresponding change in total revenue and depends on the demand curve for the firm's product. Profits are maximized at the output at which marginal cost equals marginal revenue. If profits are negative at this output, the firm should close down if this allows smaller losses.

10 An upward shift in the marginal cost curve reduces output. An upward shift in the marginal revenue curve increases output.

11 It is unnecessary for firms to calculate their marginal cost and marginal revenue curves. Setting *MC* equal to *MR* is merely a device that economists use to mimic the hunches of smart firms who correctly judge, by whatever