1

Cost Behaviour and Contribution

Objectives

When you have completed this chapter you should be able to:

- Describe different types of cost behaviour, including fixed and variable costs.
- Explain and undertake key aspects of cost–volume–profit (CVP) analysis, including:
  - Contribution analysis and how to prepare a contribution statement.
  - Break-even analysis, including the preparation of a break-even chart and calculation of the break-even point.
  - Operating gearing and its relevance to decision-making.
- Describe the assumptions that underpin cost–volume–profit analysis.

Introduction

Organizations are interested in planning for the future and understanding how revenue and costs will change when different decisions are made. Cost–volume–profit analysis examines the relationship between volume of activity, revenue, costs and profits.

The classification of costs into fixed and variable costs is discussed in the first part of the chapter. Essentially, variable costs are those that vary according to the volume of activity. The concept of contribution (revenue minus variable cost) and the preparation of a contribution statement are then explained. Break-even analysis is also discussed, and this is demonstrated by both a graphical approach and a mathematical method for calculation.

Another type of decision in a firm concerns the scale of investment in fixed costs that will be undertaken. For example, is it better to employ expensive machinery to

manufacture a product, which will involve high fixed costs, or to use lower technology, which will require less expenditure on fixed costs, but higher variable costs? Operating gearing concerns the relationship between total fixed costs and total variable costs.

In the final part of the chapter, the assumptions of cost–volume–profit analysis are reviewed. It is important to realize that the classification of costs into fixed and variable costs may be too simplistic in many organizations; for example, step fixed costs and semi-variable costs may also exist.

Cost behaviour

In order to plan for the future, it is important to understand how costs will change given different decisions made by an organization. A common method of classification is according to whether costs are variable or fixed.

Variable costs

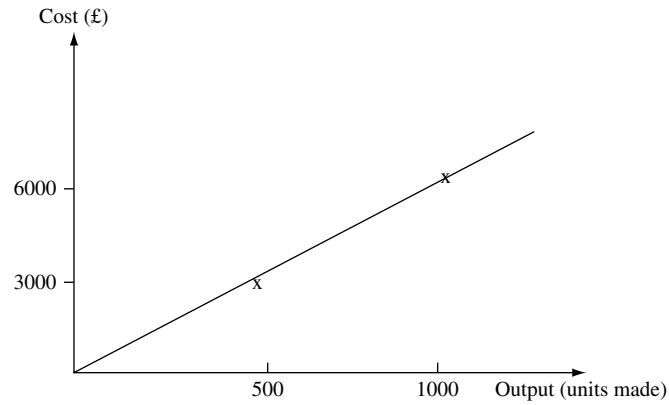
Variable costs are those that change in relation to the level of activity. Variable cost information for the manufacture of a single size of metal tube is provided in Figure 1.1.

> Sherman Ltd manufactures a single type of metal tube that would be used in the production of bicycle frames.[1] The cost information is as follows:
>
> 1. The material cost of the metal tube is calculated at £5.
> 2. The work force is paid £1 to manufacture each metal tube.

Figure 1.1 Variable costs of manufacturing metal tubes

Examining the scenario in Figure 1.1, if one unit of metal tube is manufactured, the material cost is £5. Each metal tube requires material and if two tubes are manufactured, then the total material cost will be £10 and so on. In this example, the labour cost is also a variable cost as workers are paid £1 for every tube that is manufactured. These are the only costs that increase as output increases, so the total variable costs are £6 per unit (£5 per unit for the material and £1 per unit for the labour). See Figure 1.2, which illustrates graphically the manner in which total variable costs vary in relation to output of metal tubes.

[1] For a number of the examples in this book we will use, as illustration, companies related to the manufacture of bicycles and bicycle frames. The web site for this book has reference to web sites that will describe in more detail the manufacturing process for bicycle frames. At its simplest, a bicycle frame can be considered to consist of a number of metal tubes, which are cut to size, bent and welded together.



The variable costs are £6 per unit. The table below identifies the material, labour and total variable cost at different levels of activity. For example, for 500 units, the variable cost will be 500 units multiplied by £6 a unit = £3000.

	1 unit	100 units	500 units	1000 units
	(£)	(£)	(£)	(£)
Material	5	500	2500	5000
Labour	1	100	500	1000
Total variable costs	6	600	3000	6000

Figure 1.2 Variable costs

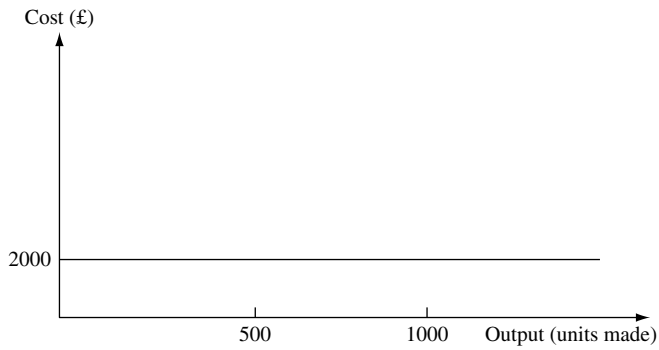
Activity 1.1

(a) Calculate the total variable cost for 600 units.
(b) Calculate the total variable cost for 900 units.

Fixed costs

A **fixed cost** does not vary with the output level. For example, cost of rent for premises, lease payment on equipment and items such as rates and standing charges on utilities have to be paid regularly regardless of the activity being carried out within the business. In Sherman Ltd, to manufacture the metal tubes, it has also been necessary to lease

a machine at £1200 per month. Other costs are also £800 per month and these must be paid whether or not components are made. This gives a total cost of £2000 per month that must be paid each month. See Figure 1.3, which plots fixed costs in relation to output.



Whether 1 unit, 500 units or 1000 units are made, the cost of the lease of the machine, rent of the building and other costs remains constant at £2000.

Figure 1.3 Fixed costs

Total cost

For Sherman Ltd, it is possible to identify the total cost by adding the variable costs to the fixed costs. This is demonstrated in Figure 1.4.

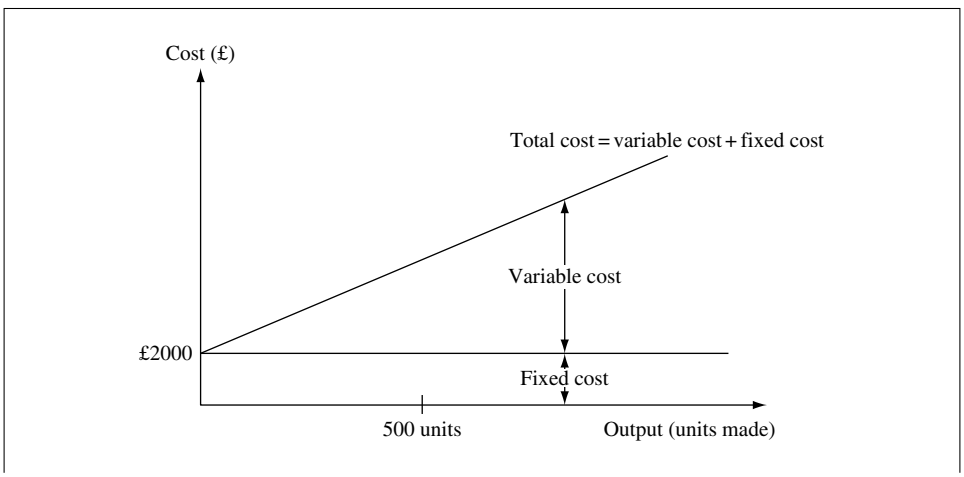


Figure 1.4 Total costs

	1 unit (£)	100 units (£)	500 units (£)	1000 units (£)
Material	5	500	2500	5000
Labour	1	100	500	1000
Total variable costs	6	600	3000	6000
Fixed cost	2000	2000	2000	2000
Total cost	2006	2600	5000	8000

The total cost = variable cost + fixed cost.
So for 500 units:
Total cost = variable cost (500 units × £6 per unit = £3000) + fixed costs of £2000
= £5000

Figure 1.4 (*Continued*)

Contribution and the contribution statement

Cost–volume–profit (CVP) analysis is based on the relationship between sales volume (in units) and sales revenue, costs and profit. Once an organization has identified its variable and fixed costs, given the knowledge of its revenue at different levels of sales, it is also possible to calculate the profit at these different levels. Table 1.1 shows the total revenue, variable and fixed costs and profit or loss given different sales of 1, 500, 1000 and 1500 units sold.

Table 1.1 Revenue, cost and profit statement for Sherman Ltd

	1 unit (£)	500 units (£)	1000 units (£)	1500 units (£)
Total sales revenue	8	4,000	8,000	12,000
Variable cost	6	3,000	6,000	9,000
Fixed cost	2,000	2,000	2,000	2,000
Total cost	2,006	5,000	8,000	11,000
Profit/(loss)	(1,998)	(1,000)	0	1,000

Note that if a loss is made this is shown in brackets.
Profit = total sales revenue – total cost
Total sales revenue = sales price per unit multiplied by number of units sold
Total cost = variable cost plus fixed costs
Variable cost = variable cost per unit multiplied by number of units sold

Activity 1.2

Prepare a profit statement for Sherman Ltd if:

(a) 600 units are sold.
(b) 900 units are sold.

Rather than showing information in tables, many managers like to view information in a graphical format. An example is the profit/loss chart shown in Figure 1.5, which shows the profit or loss generated at different levels of output.

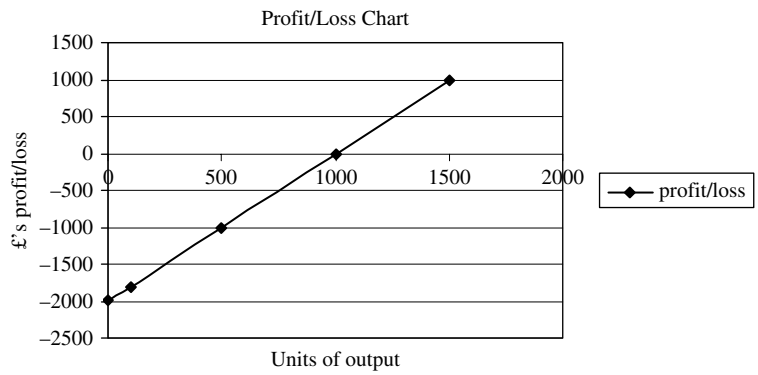


Figure 1.5 Profit/loss chart for Sherman Ltd

Table 1.1 and Figure 1.5 have been helpful in identifying the profit and loss at various levels of activity. For example, it is possible to see that at 1000 units of output the company is in a break-even situation, i.e. total costs are equal to the revenue. Above 1000 units a profit is made and below 1000 units there will be a loss.

The contribution statement

In order to more clearly identify the impact of changes in volume on costs and profits, it is usually considered helpful to produce a contribution statement as well as a profit statement. **Total contribution** is defined as the total sales revenue less total variable costs. The **contribution per unit** is the sales revenue per unit – the variable cost per unit.

The format of a contribution statement is as follows:

	Total sales revenue
Less	variable costs
	= contribution
Less	fixed cost
	= Net Profit

The contribution statement shows the contribution that is made after variable costs are deducted from sales. Fixed costs are then deducted from the contribution to show the net profit or loss that is generated. A contribution statement for Sherman Ltd is shown in Table 1.2. This highlights that the break-even point occurs at 1000 units, with profits generated above that point.

Table 1.2 Contribution statement for Sherman Ltd

	1 unit (£)	500 units (£)	1000 units (£)	1500 units (£)
Total sales revenue	8	4,000	8,000	12,000
Variable cost	6	3,000	6,000	9,000
Contribution	2	1,000	2,000	3,000
Fixed cost	2,000	2,000	2,000	2,000
Profit/(loss)	(1,998)	(1,000)	–	1,000

Activity 1.3

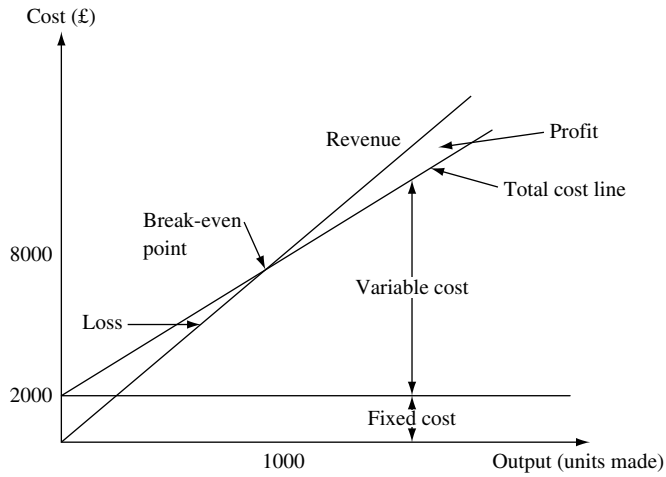
Prepare a contribution statement for Sherman Ltd if:

(a) 900 units are produced.
(b) 1200 units are produced.

Break-even analysis

Break-even analysis is a business tool that can help to identify at what activity level the business will move from making a loss to a profit. The moment that this happens is known as the **break-even point**.

The break-even chart provides more information than the profit volume chart, by identifying revenue, fixed costs and variable costs at different volumes of output and sales. The charts also highlight the break-even point. See Figure 1.6.



From the graph it can be seen that the break-even point is at 1000 units. Below 1000 units, the business will make a loss. Above 1000 units, the business will make a profit.

Figure 1.6 Break-even chart

An alternative chart that is sometimes used is known as the contribution chart. The difference from the break-even chart is that the variable cost line is drawn first and then the fixed cost line is added. See Figure 1.7.

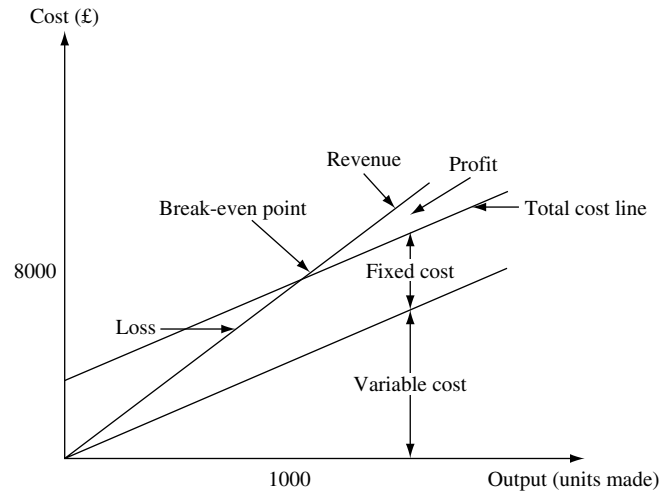


Figure 1.7 Contribution chart

Calculating the break-even point

The break-even point can also be calculated using the contribution approach. For the worked example above, the contribution earned for every unit sold would be:

		£
	Selling price per unit	8
Less	Variable cost per unit	6
	Contribution per unit	2

The revenue increases by £8 for every extra unit sold while costs increase by £6 if one additional unit is made. Therefore the net effect on the business of making and selling an additional unit is £2. This additional £2 is called the contribution per unit (selling price per unit – variable cost per unit).

Given the contribution per unit, it is possible to identify the number of units needed to cover the fixed overheads of the business. If every unit sold provides a contribution of £2 and if the fixed overheads are £2000, then 1000 units need to be sold to make a contribution of £2000.

The break-even point can be calculated using the formula:

$$\text{BEP} = \frac{\text{Fixed cost}}{\text{Contribution per unit}} = \frac{£2000}{£2} = 1000 \text{ units}$$

To see how the formula is derived, see the explanation in Figure 1.8.

Profit = total sales revenue − total costs

i.e. Profit = sales price per unit × number of units sold − (fixed costs + variable cost per unit × number of units sold)

Note that this calculation can be expressed as a mathematical equation:

i.e. Profit $= PX - (a + bX)$

where

P = sales price per unit
X = number of units sold
a = fixed cost
b = variable cost per unit

The break-even point occurs when there is no profit:

$$0 = PX - (a + bX) = PX - a - bX$$

This formula can be rearranged as:

$$a = PX - bX \quad \text{or} \quad a = (P - b)X$$

This formula in turn can be rearranged as:

$$X = \frac{a}{(P - b)}$$

i.e.

$$\text{Break-even point} = \frac{\text{Fixed cost}}{\text{(Sales revenue per unit – variable cost per unit)}}$$

Figure 1.8 Deriving the formula to calculate the break-even point

Activity 1.4

Assume that a company sells a product with a variable cost of £6. The product can be sold for £12 and the fixed costs are £3000.

(a) How many products need to be sold in order that the break-even point is reached?
(b) If the price went up to £14 and fixed costs increased to £4000, what would be the new break-even point?

Calculating the sales to earn a set profit

If Sherman Ltd wanted to earn a profit of £1000 a month then it would be necessary to sell enough units to make a contribution that would cover the overheads and earn a further £1000.

Units to be sold to make £1000 profit =

$$\frac{\text{Fixed cost} + \text{target profit}}{\text{Contribution per unit}} = \frac{(£2000 + £1000)}{£2} = 1500 \text{ units}$$

Activity 1.5

(a) How many units would need to be sold to generate a profit of £1500?
(b) How many units would need to be sold to generate a profit of £3000?

Calculating the margin of safety

The **margin of safety** is the extent to which sales are above the break-even point. For Sherman Ltd, the break-even point is 1000 units. If actual units sold were 1500, then there would be a margin of safety of 500 units. This means that sales can fall by up to 500 units before the organization would incur a loss. For an organization it would generally be considered that the larger the margin of safety, the better!

The margin of safety is also often expressed as a percentage of expected sales, and the calculation of the margin of safety for Sherman Ltd is shown in Figure 1.9.

To calculate the expected margin of safety it is necessary to identify the expected sales and the break-even sales. For Sherman Ltd:

$$\text{Expected sales in units} - \text{break-even sales in units} = \text{Margin of safety (units)}$$

$$1500 - 1000 = 500 \text{ units.}$$

The margin of safety is often expressed as a percentage of expected sales:

$$\text{Percentage margin of safety} = \frac{\text{Expected sales units} - \text{break-even sales units}}{\text{Expected sales units}} \times 100\%$$

So for Sherman Ltd

$$\text{At 1500 units} = \frac{1500 - 1000}{1500} = 33\%$$

This means that sales could fall by up to 33% before a loss was experienced.

Figure 1.9 Calculation of margin of safety of Sherman Ltd

Activity 1.6

The break-even point for an organization is 1200 units.

(a) Calculate the percentage margin of safety if the expected sales are 2000.
(b) Calculate the percentage margin of safety if the expected sales are 3000.

An example of an organization that failed to sell a sufficient volume of its product is discussed in Figure 1.10.

In July 2006, *The Sportsman*, the first national daily newspaper to be launched for two decades, fell into administration.

When *The Sportsman* was launched at the beginning of 2006, its backers said that the paper would appeal to a new generation of sports and poker players, as well as traditional horseracing fans. The paper indicated that it needed to sell 40,000 copies to break even.

The paper initially sold 65,000 copies, however by May 2006 the average daily sale was 12,762.

Figure 1.10 Launch of *The Sportsman* newspaper
Source: *The Times*, 21 July 2006.

In the case of *The Sportsman* newspaper initial sales were 65,000 units. Since only 40,000 units were required to break even, the management may have felt some confidence that they could compete on a profitable basis, because sales would have to fall by 25,000 before a loss situation would occur. Unfortunately, this margin of safety was only temporary and when sales fell to about 13,000 units, the administrators were called in.

Operating gearing

Often an organization has a choice on whether to invest heavily in fixed costs and incur lower variable costs per unit, or to invest less in fixed costs and incur higher variable costs per unit. **Operational gearing** is the relationship between fixed and variable costs.

Organizations which are capital-intensive and where fixed costs are high as a proportion of total costs are considered to have high operational gearing. Organizations where fixed costs are low as a proportion of total costs have low operational gearing. Consider the example in Figure 1.11.

The lease of the machine that is involved in the manufacture of metal bicycle tubes is up for renewal. It is possible to manufacture bicycle tubes by using a labour-intensive process and this would avoid the cost of leasing the machine. The labour cost per tube would, however, rise to £2 per unit. The management of Sherman Ltd are considering which process to adopt.

The total cost of each process can be calculated at different volumes.

With the machine (higher operational gearing)

	1 unit (£)	500 units (£)	1000 units (£)	1500 units (£)
Sales	8	4,000	8,000	12,000
Variable cost	6	3,000	6,000	9,000
Contribution	2	1,000	2,000	3,000
Fixed cost	2,000	2,000	2,000	2,000
Profit/(loss)	(1,998)	(1,000)	–	1,000

Without the machine (lower operational gearing)

	1 unit (£)	500 units (£)	1000 units (£)	1500 units (£)
Sales	8	4,000	8,000	12,000
Variable cost	7	3,500	7,000	10,500
Contribution	1	500	1,000	1,500
Fixed cost	800	800	800	800
Profit/(loss)	(799)	(300)	200	700

Figure 1.11 Profit/(Loss) given different operating gearing

With the lease of the machine Sherman Ltd becomes more highly geared. This means that at low volumes of sales, e.g. under about 1000 units, larger losses are incurred than would be the case without the machine. At 500 units, for example, the loss with the machine is £1000, while without the machine the loss is £300.

At 1000 units, a profit of £200 per month would be generated if no machine was leased, while with the leased machine, the company is only in a break-even situation.

At a production level of 1500 units, the company is generating a profit of £1000 with the machine, while it would only be £700 without the machine.

In deciding whether to lease the machine or not, the company needs to consider the likely level of sales. If there is a significant chance that sales will fall to low levels, then it might be best to keep a low operational gearing, even though this will mean a higher level of variable costs.

Figure 1.11 (*Continued*)

In recent years a number of organizations have adopted a policy of low gearing to limit the potential losses, if sales fall. For example, rather than employing full-time training staff, they might buy in training staff when required and pay them a daily rate for their work.

Activity 1.7

An organization is considering alternative policies for the future. It can sell a product for £20 and is not sure whether to invest heavily in new technology or to choose a less capital-intensive option.

(a) If it invests in the heavily capital-intensive option, the fixed costs per month will be £5000 and the variable cost per unit will be £8.
(b) If it invests in the less capital-intensive option, the fixed costs per month will be £2000 and the variable cost per unit will be £12.

Advise the company on the circumstances in which each option should be chosen.

Activity 1.8

AB Ltd currently employs three full-time trainers who earn £35,000 each. Overheads involved with the training department are £50,000 per year. It currently runs 300 training days of courses a year and is considering whether to subcontract the training to freelance trainers. It would have to pay these trainers £400 per day. Overheads would reduce to £30,000 if outside trainers were employed. Advise the company on what it should do.

Assumptions of break-even analysis

It is vital that the individual preparing or interpreting information on costs and revenue is aware of the assumptions that have been made, otherwise errors can occur. Assumptions in CVP analysis that need to be tested include:

1. Fixed costs will stay the same for any given level of output.
   In the example of Sherman Ltd, it has been assumed that the fixed costs will be £2000 whether one metal bicycle tube is manufactured or 1500 units are manufactured.
2. The sales price is constant whatever the sales volume.
3. The variable cost per unit is constant whatever the level of output.
4. Costs can be accurately divided into fixed or variable elements.

Considering these assumptions in more detail

(1) Fixed costs will stay the same whatever the level of output

In many instances this is unlikely to be the case. Fixed costs may only be fixed within a certain level of activity and beyond that level, fixed costs will need to increase; these are **step-fixed costs**. For example, it might be that Sherman Ltd can make 1500 units of output in its current premises, with the existing machine. Above that production level, it might be necessary to lease an additional machine and rent additional floor space at an additional cost of £1500 per month, as illustrated in Figure 1.12.

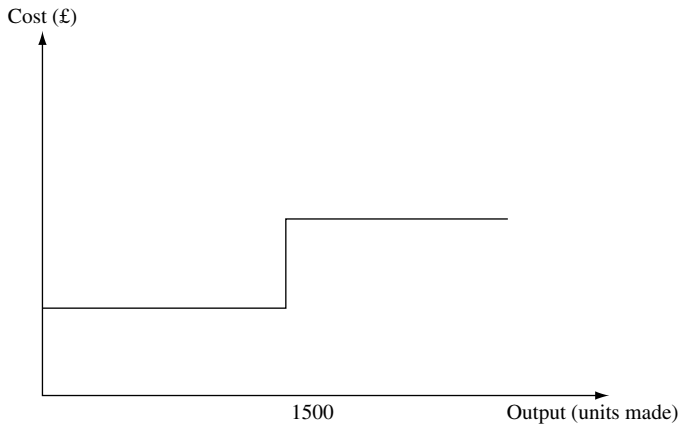


Figure 1.12 Step-fixed costs

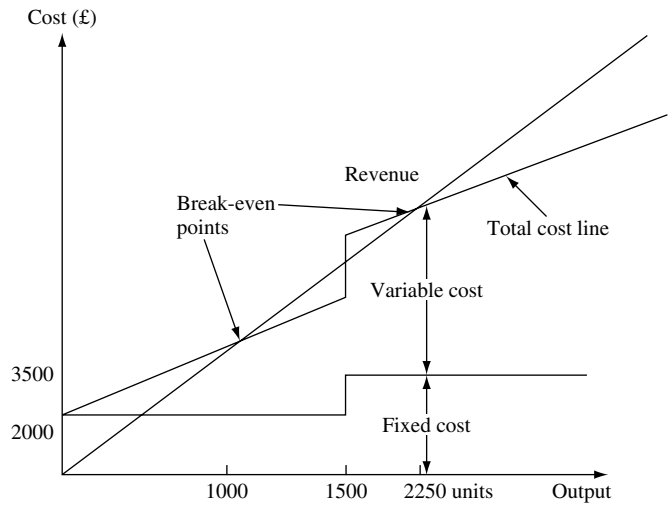
Given this knowledge of step-fixed costs, it is possible to produce a revised contribution table for Sherman Ltd to cover a larger range of output. See Table 1.3.

Table 1.3 Contribution statement for 1 unit, 1500 units, 1750 units and 2500 units sold

	1 unit (£)	1000 units (£)	1500 units (£)	1750 units (£)	2250 units (£)
Sales	8	8,000	12,000	14,000	18,000
Variable cost	6	6,000	9,000	10,500	13,500
Contribution	2	2,000	3,000	3,500	4,500
Fixed cost	2,000	2,000	2,000	3,500	3,500
Profit/(loss)	(1,998)	–	1,000	–	1,000

An analysis of this table reveals that there are two break-even points. If production of bicycle tubes goes above 1500 units a week, then the increase in fixed costs of £1500 will mean that the company must achieve sales of 2250 units before the same profit is generated from sales as is achieved at 1500 units.

A break-even chart can also be produced for Sherman Ltd, which will reflect the revenue, costs and profit for a range in output from 0 to 3000 units. This is illustrated in Figure 1.13.



This chart indicates the two break-even points, the first when sales are 1000 units and the second at sales of 1750 units.

Figure 1.13 Break-even chart

The term 'relevant range' is used to indicate the range over which cost and revenue assumptions are valid. For example, the assumption is made in the break-even chart for Sherman Ltd that up to 3000 units, the increase in variable costs is linear, i.e. it increases by £6 per unit whether 1 unit is made or 3000 units are made. Fixed costs are assumed

to increase only once at 1500 units. If above 3000 units these assumptions are no longer valid, then the relevant range for this analysis is between 0 and 3000 units.

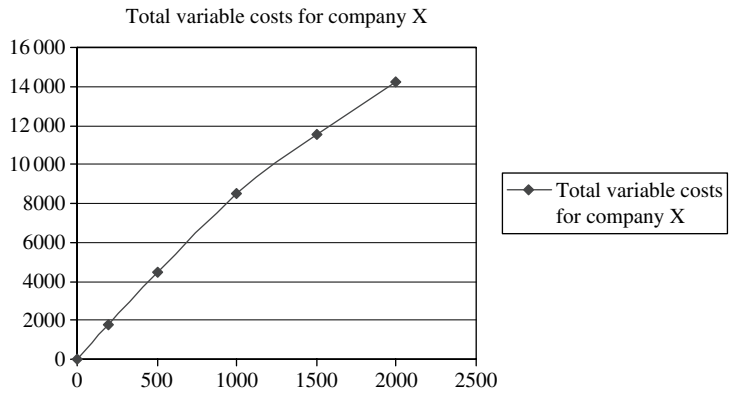
(2) The sales price per unit is constant, whatever the sales volume

In the example of Sherman Ltd, it is assumed that the sales price per unit remains at £8 per unit, whatever the level of activity. To achieve a volume greater than 1500 units it might be necessary to discount this price. This is discussed further in Chapter 2, when demand-based pricing is considered.

(3) The variable cost per unit is constant, whatever the volume of output

(a) The variable costs per unit might change. For example, if the company purchases additional raw material, it may be possible to arrange additional discounts to allow for bulk buying. At higher levels of output, it might be possible to achieve a lower variable labour cost per unit, for example due to efficiency improvements. Alternatively, it could be necessary to work overtime, which would mean that variable labour cost per unit would increase.

Figure 1.14 demonstrates a graph showing the marginal cost per unit decreasing at higher volumes for 'company X'.



In the above diagram it can be seen that the increase in the marginal cost for an organization is not linear, since at higher volumes it has been possible to achieve cost savings per unit.

Figure 1.14 Total variable costs assuming efficiency improvements

(b) Some costs may change in proportion to an activity other than output. For example, costs of purchasing might change in proportion to the number of purchase orders raised rather than the number of units produced. Dealing with this problem will be considered in more detail in Chapter 6.

(c) A company is likely to produce a number of products, which earn different contributions. If the sales mix of the company changes, then this is likely to change the average cost, sales value and contribution per unit sold. This is illustrated in Figure 1.15.

Demand for the metal tube size 1 has fallen to 500 units per month and Sherman Ltd is considering manufacturing a second size of tube that can be sold for £10.50. It is estimated that 500 size 2 tubes could also be sold per month.

Cost information for tube size 2 is as follows:
1. Material cost per tube is £6.
2. Labour cost per tube is £1.50. (The tube takes 15 minutes to manufacture.)
3. Fixed overheads at the factory remain at £2000 per month.

The management of Sherman Ltd wish to know the impact on their profits of making this decision.

The contribution for 500 units for metal tube size 1 is:

	500 units
	(£)
Sales	4000
Variable cost	3000
Contribution	1000

The variable cost for metal tube size 2 is £7.50 (material of £6 and labour of £1.50). Also given a selling price of £10.50 per tube, the contribution for 500 tubes is:

	500 units
	(£)
Sales	5250
Variable cost	3750
Contribution	1500

The analysis below shows the contribution that is earned from both the sale of 500 units of size 1 tubes and 500 units of size 2. A total contribution can then be calculated.

If fixed costs are deducted from the total contribution this will give the net profit.

	Tube size 1 500 units	Tube size 2 500 units	Total
	(£)	(£)	(£)
Sales	4000	5250	9250
Variable cost	3000	3750	6750
Contribution	1000	1500	2500
Fixed cost			2000
Profit/(loss)			500

It is possible to tell the management of Sherman Ltd that tube size 1 makes a contribution of £1000 to overheads, while tube size 2 makes a contribution of £1500. Both therefore make a positive contribution to overheads.

The contribution of tube size 1 is £2 per unit and the contribution of tube size 2 is £3 per unit.

If equal numbers of both products are sold then the average contribution per unit sold would be £2 × 50% + £3 × 50% = £2.50 and the break-even point at low volumes would be £2000/£2.50 = 800 units.

If the proportion of each product changes then so will the average contribution per unit and the number of units required to break even. For example, assume that the sales mix changes so that 75% of units sold are of type tube size 1, which earn a contribution of £2 and 25% are of tube size 2, which earn a contribution of £3. Then the average contribution sold would

Figure 1.15 Break-even point given multiple products

be £2 × 75% + £3 × 25% = £1.5 + £0.75 = £2.25. To break even it would be necessary to sell £2000/£2.25 = 889 units. On the other hand, if more of the units that earn a contribution of £3 per unit were sold, the average contribution per unit would increase and the number of units that need to be sold to break even would reduce.

Note the cost assumptions:
1. That fixed costs will not change, with the increased complexity of making two products.
2. That variable costs and revenue are constant per unit of output.

Figure 1.15 (*Continued*)

Activity 1.9

What is the average contribution per unit and how many units need to be sold to cover fixed costs of £2000 if:

(a) 60% of units made and sold are of type tube size 2, earning a contribution of £3 and 40% are of type tube size 1, earning a contribution of £2.
(b) 45% of units made and sold are of type tube size 2, earning a contribution of £3 and 55% are of type tube size 1, earning a contribution of £2.
(c) Other variables change, e.g. production efficiency and production methods, which in turn may cause a change in the variable costs per unit.

(4) Costs can be accurately divided into fixed or variable elements

This is not always the case as costs can change in more complex ways. A number of costs also have both a fixed and a variable element and are **semi-variable costs**, as illustrated in Figure 1.16. An example is the electricity charge paid by many people.

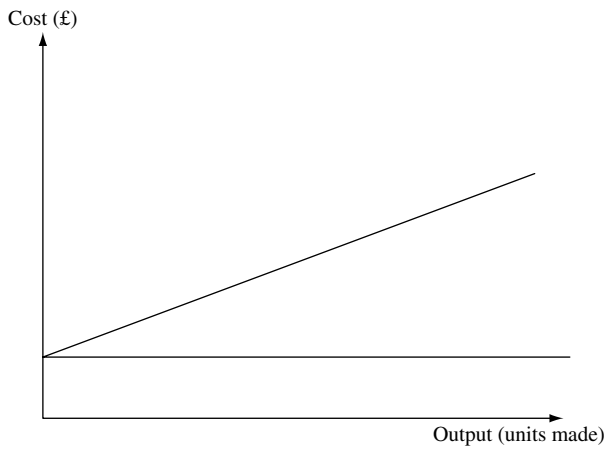


Figure 1.16 A semi-variable cost

Summary

Fixed costs are those that do not change in relation to changes in output. Variable costs vary directly in proportion to output.

Cost–volume–profit analysis is concerned with identifying the changes in cost and revenue at different levels of output.

Contribution is revenue minus variable costs and a contribution statement shows the contribution generated from sales for a particular product or organization before deducting fixed costs.

A break-even chart illustrates the loss or profit earned at different levels of activity and the point at which costs equal revenue, i.e. the break-even point. The break-even point as well as margin of safety and sales required to generate a certain level of profit can also be calculated.

Low operating gearing occurs where fixed costs form a low proportion of the total costs of a firm. If there is a significant chance that sales will fall to low levels, then it will be easier for a firm to reduce costs if it has low operational gearing. However, if sales are high then profits are likely to be less than for a firm with high operational gearing.

Cost behaviour and contribution analysis is only valid given the validity of the assumptions on which the calculations are based. It is not always possible to classify costs as purely fixed or variable. Fixed costs for example may only be fixed within a certain level of activity and beyond this level an increase is required (a step fixed cost), while other costs may have a fixed and a variable element (a semi-variable cost).

Answers to activities

Activity 1.1

	600 units (£)	900 units (£)
Total variable costs	3600	5400

Activity 1.2

	600 units (£)	900 units (£)
Sales	4800	7200
Variable cost	3600	5400
Fixed cost	2000	2000
Total cost	5600	7400
Profit/(loss)	(800)	(200)

Activity 1.3

	900 units (£)	1200 units (£)
Sales	7200	9600
Variable cost	5400	7200
Contribution	1800	2400
Fixed cost	2000	2000
Profit/(loss)	(200)	400

Activity 1.4

(a) The contribution per unit is £12 – £6 = £6.
The break-even point = £3000/6 = 500 units
(b) The contribution per unit is £14 –£6 = £8.
The break-even point = £4000/8=500 units

Activity 1.5

$$\frac{\text{Fixed cost} + \text{target profit}}{\text{Contribution per unit}} = (£2000+£3000)/£2 = 1750 \text{ units}$$

$$\frac{\text{Fixed cost} + \text{target profit}}{\text{Contribution per unit}} = (£2000+£3000)/£2 = 2500 \text{ units}$$

Activity 1.6

$$\text{Percentage margin of safety} = \frac{\text{Expected sales} - \text{break-even sales}}{\text{Expected sales}} \times 100\%$$

(a) $\dfrac{2000-1200}{2000} \times 100\% = 40\%$

(b) $\dfrac{3000-1200}{3000} \times 100\% = 60\%$

Activity 1.7

Option (a)

$$\text{Break-even point} = \frac{\text{Fixed cost}}{\text{Contribution per unit}} = \frac{£5000}{£12} = 417 \text{ units}$$

With the new technology

	1 unit (£)	250 units (£)	500 units (£)	750 units (£)	1000 units (£)
Sales	20	5,000	10,000	15,000	20,000
Variable cost	8	2,000	4,000	6,000	8,000
Contribution	12	3,000	6,000	9,000	12,000
Fixed cost	5,000	5,000	5,000	5,000	5,000
Profit/(loss)	(4,988)	(2,000)	1,000	4,000	7,000

Option (b)

$$\text{Break-even point} = \frac{\text{Fixed cost}}{\text{Contribution per unit}} = \frac{£2000}{£8} = 250 \text{ units}$$

With the less capital intensive option

	1 unit (£)	250 units (£)	500 units (£)	750 units (£)	1000 units (£)
Sales	20	5,000	10,000	15,000	20,000
Variable cost	12	3,000	6,000	9,000	12,000
Contribution	8	2,000	4,000	6,000	8,000
Fixed cost	2,000	2,000	2,000	2,000	2,000
Profit/(loss)	(1,992)	–	2,000	4,000	6,000

The two projects generate the same return at 750 units. Below that level, option (b) is more profitable/has a lower break-even point. Above 750 units, option (a) is more profitable. The management of the company need to consider the likelihood of sales being above or below 750 units.

Activity 1.8

Three full-time trainers at £35,000 = £105,000

Overheads	£50,000
Total costs	£155,000

300 training days at £400 per day = £120,000

Overheads	£30,000
	£150,000

It seems that it is £5000 cheaper to subcontract the training to outside trainers.

The assumption on the expected number of training days should be checked. If the days required increases above 306, then it may be worthwhile continuing with the existing three trainers. Cost assumptions need to be checked, including the impact on overheads and possible costs of redundancy.

Non-financial factors should also be considered; for example, are the outside trainers of equal quality to the internal staff and will the organization be losing a resource that does more than just provide the 300 training days.

Activity 1.9

(a) £3 × 60% + £2 × 40% = £1.80 + £0.80 = £2.60. To break even it would be necessary to sell £2000/£2.60 = 770 units.
(b) £3 × 45% + £2 × 55% = £1.35 + £1.10 = £2.45. To break even it would be necessary to sell £2000/£2.45 = 817 units.

Discussion questions

1. What information does a break-even chart show?
2. Explain the difference between profit and contribution.
3. Explain the following terms:

   Relevant range
   Operating gearing
   Margin of safety.

4. In what circumstances might a break-even chart provide misleading information?
5. Why might an understanding of the margin of safety be of interest to managers?
6. What is the difference between a profit–volume chart and a break-even chart?
7. When deciding to start a business, why might it be important to take into consideration the proposed operating gearing?

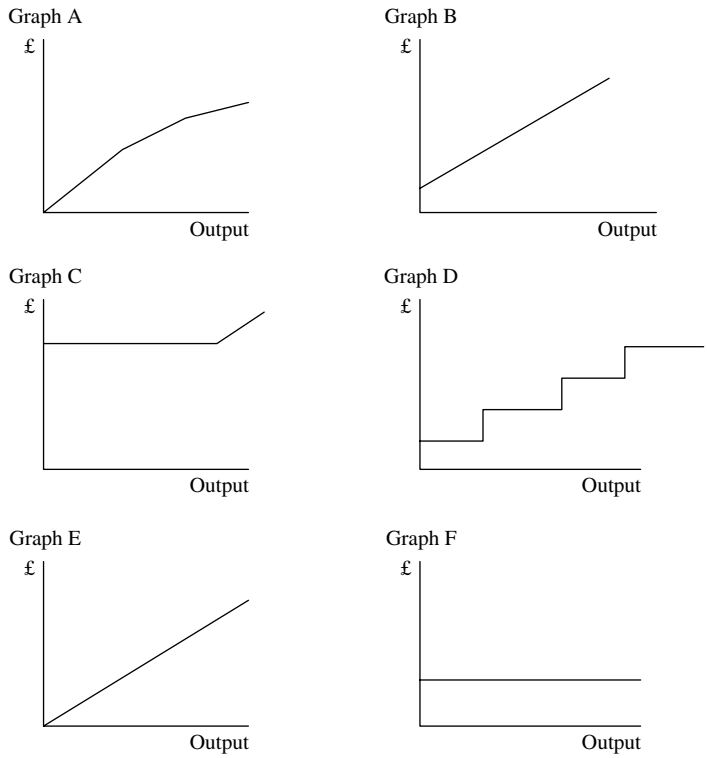
Exercises

(Questions in bold have answers at the back of the book.)

Q1.1 Read the following descriptions and match the description with the graphs shown beneath.

(i) Rent on a factory is £2000 per month.
(ii) An additional supervisor is needed for every 1000 units produced.
(iii) A telephone bill consists of a standing charge of £10 per month and then a charge per minute.

(iv) A supplier charges £25 per kg of raw material for the first 1000 kgs, then £18 per kg for the next 1000 kgs and £16 per kg for all kgs ordered over 2000.
(v) Material costs of a product are £5 per unit.
(vi) Labourers are paid a flat wage for the first 2000 units that they work. For all units over that volume they are paid a bonus of £1 per unit.



Q1.2 A company produces a single product – the Widget.

Selling price is £15 per unit.

Variable costs are £10.

Fixed costs are £40,000 a month.

Expected sales are 10,000 units per month. Maximum capacity is 12,000 units.

Required:

1. Draw a break-even chart, showing the break-even point.
2. Calculate the break-even point and the margin of safety if expected sales are achieved.

Q1.3 The company in Question 1.2 above is considering introducing a second product – the Didget. Anticipated selling price and costs are as follows. Selling price is £20 per unit, variable costs £14 and fixed costs will remain at £40,000. It is expected that sales of the Didget will be 2000 units per month. Sales of the Widget will, however, reduce to 9000 units.

Required:

Calculate the break-even point given this product mix and the margin of safety.

Q1.4 Company X expects to sell 1500 shirts a month at £10 per shirt. The purchase price is £5 and overheads are £5000 a month.

Required:

(i) How many shirts are needed to break even and what is the margin of safety?
(ii) How many shirts does the company need to sell to make a profit of £2000 per month?
(iii) The marketing manager suggests that the price per shirt be reduced to £9. He believes that this will result in an additional 400 shirts being sold. Is the marketing manager correct in believing that the sales price reduction would be worthwhile?

Q1.5 Company Y expects to sell 12,000 shirts a month at £22 per shirt. The purchase price is £13 per shirt and overheads are £60,000 a month.

Required:

(i) How many shirts need to be sold to break even and what is the margin of safety given the existing level of sales?
(ii) How many shirts does the company need to sell to make a profit of £20,000 per month?
(iii) The sales manager suggests that the price per shirt be reduced to £19.50. He believes that this action will result in an additional 2000 shirts being sold. Advise whether this would be a worthwhile initiative.

Q1.6 Apple Ltd produces a single product – the 'Peardrop'.

The selling price of a Peardrop is £20 per unit.
The Peardrop can be made using a manual process or using machinery.
If made manually:

The variable cost per unit will be £13 and the fixed costs will be £40,000 per month.

If the machinery is leased:

The variable cost per unit will fall to £10 per unit, but fixed costs will increase to £60,000 per month.

Expected sales are 10,000 units per month. Maximum capacity with both processes is 12,000 units.

Required:

(i) Calculate the likely contribution if the Peardrop is made manually and if the machinery is leased.
(ii) Identify the break-even point and margin of safety given both options.
(iii) Would you advise the management of Apple Ltd to lease the machinery or to continue to use the manually intensive process?