Contribution analysis

Tough at the top

Alcatel-Lucent surges on break-even target

FT

Andrew Parker

Alcatel-Lucent, the Franco-American telecoms equipment maker, on Thursday slipped to an operating loss in the second quarter, but said it still planned to break even for the full year.

Ben Verwaayen, Alcatel-Lucent's chief executive, said the company expected to hit its target of break-even at the level of adjusted operating income, partly through further cost cutting.

Mr Verwaayen is leading a turn-round of the telecoms equipment maker, which has yet to make a success of the 2006 merger between its French and American predecessor companies.

All the telecoms equipment manufacturers are getting hit in the economic downturn, as fixed line and mobile phone operators cut their capital spending.

The company reported revenue of €3.9bn ($5.5bn) for the three

months to June 30, down 4.8 per cent compared to the same period last year.

It recorded net income of €14m, compared to a €1.1bn loss in the second quarter last year. The improvement was because of some one-off items, including a €255m tax-free capital gain on the sale of Alcatel-Lucent's 21 per cent stake in Thales, the French defence electronics maker.

www.ft.com, 30 July 2009.

Source: Reproduced with permission from *The Financial Times*.

About this chapter

In the previous two chapters we have been concerned with the planning and control functions of management accounting. We now turn our attention to another important function of management accounting, *decision making*. In this chapter we explore a basic technique of decision making known as *contribution analysis*.

Contribution analysis is based on the premise that in almost any decision-making situation some costs are irrelevant, that is they are not affected by the decision. They can, therefore, be ignored. In such circumstances management should concentrate on the *contribution* that a project may make. Contribution (C) is the difference between the sales revenue (S) of a project and the variable or extra costs (V) incurred by investing in that project. Other things being equal, as long as S – V results in C being positive then management should go ahead or continue with the project. If C is positive it means that something is left over to make a *contribution* to the fixed (or remaining) costs (F) of the entity. If the fixed costs have already been covered by other projects then the contribution increases the entity's profit.

Learning objectives	By the end of this chapter, you should be able to:

- explain why absorption costing may be inappropriate in decision making;
- describe the difference between a fixed cost and a variable cost;
- use contribution analysis in managerial decision making;
- assess the usefulness of contribution analysis in problem solving.

❗ Why this chapter is important

Of all the chapters in this book this is the most relevant and vital for non-accountants. Why? Whatever job you are doing and at whatever level, you will be required to make or to take decisions. Many of those decision will be straightforward day-to-day ones such as, '*Do we order a week's or a month's supply of paper towels?*' Other decisions will be more significant and long-term, for example '*Should we increase our selling prices?*' or '*Do we buy this other company?*'

While there is a cost implication in these sorts of decisions, it is unlikely that you would have to do the detailed calculations for yourself. Your accountants will do this for you and then present you with the results. However, in order to make sense of the information and to take an informed decision you need to know where the information has come from and how it has been compiled.

This is a valid point irrespective of the particular issue but it is especially valid for specific one-off decision making. If such decisions are based on absorbed costs you might make a spectacularly wrong decision because it would not be based on the project's *relevant* costs, i.e. those costs that are affected by that particular decision.

This chapter will help you to appreciate more clearly the nature of relevant costs and their importance in managerial decision making. As a result, you will be able take more soundly based decisions and be more confident about their eventual outcome.

Marginal costing

News clip

Outsourcing

According to a report by Create Research, asset managers are cutting their fixed costs by outsourcing instead of carrying out middle and back office jobs in-house. Stephen Wynne, chief executive of PNC Global Investment Services, admits that such a move causes some restructuring costs but 'the fixed expense becomes a variable one'.

Source: Adapted from www.ft.com/cms/s, 5 April 2009.

Chapters 13 and 14 dealt with cost accounting. The costing method described in some detail in those chapters is known as *absorption costing*. The ultimate aim of absorption costing is to charge out all the costs of an entity to individual units of production.

The method involves identifying the *direct costs* of specific units and then absorbing a share of the *indirect costs* into each unit. Indirect costs are normally absorbed on the basis of direct labour hours or machine hours. Assuming that an overhead absorption rate is predetermined, i.e. calculated in advance, this method involves estimating the total amount of overhead likely to be incurred and the total amount of direct labour hours or machine hours expected to be worked. So the absorption rate could be affected by the total cost of the overhead, the hours worked or by a combination of cost and hours.

The total of the indirect costs (the overhead) is likely to be made up of a combination of costs that will change depending on how many units a department produces and those costs that are not affected by the number of units produced. Costs that change with activity are known as *variable costs*. It is usually assumed that variable costs vary directly with activity, e.g. if 1 kg costs £1, then 2 kg will cost £2, 3 kg will cost £3 and so on. Those costs that do not change with activity are known as *fixed costs*.

As we argued in Chapters 13 and 14, if we are attempting to work out the total cost of manufacturing particular units, or if we want to value our stocks, it is appropriate to use absorption costing. Most cost book-keeping systems are based on this method of costing but absorption costing is not normally appropriate in decision making as the fixed element inherent in most costs may not be affected by a particular decision.

Suppose that a manager is costing a particular journey that a member of staff is proposing to make to visit a client. The staff member has a car that is already taxed and insured, so the main cost of the journey will be for petrol (the car may also depreciate slightly more quickly and it may require a service sooner). The tax and insurance costs will not be affected by one particular journey: they are *fixed costs*, no matter how many extra journeys are undertaken. The manager is, therefore, only interested in the *extra* cost of using the car to visit the client and he can then compare the cost of using the car with the cost of the bus, the train or going by air. Note that cost alone would not necessarily be the determining factor in practice; non-quantifiable factors such as comfort, convenience, fatigue and time would also be important considerations.

The extra cost of making the journey is sometimes described as the *marginal cost*. Hence the technique used in the above example is commonly referred to as *marginal costing*. Economists also use the term 'marginal cost' to describe the extra cost of making an additional unit (as with the extra cost of a particular journey). When dealing with production activities, however, units are more likely to be produced in batches. It would then be more appropriate to substitute the term *incremental costing* and refer to the *incremental cost*, meaning the extra cost of producing a batch of units. As the terms 'marginal costing' and 'marginal cost' are so widely used, however, we will do the same.

The application of marginal costing revolves round the concept of what is known as *contribution*. We explore this concept in the next section.

Activity 17.1	A business college has recently considered starting some extra evening classes on basic computing. The college runs other courses during the evening. The proposed course fee has been based on the lecturer's fee and the cost of heat, light, caretaking and other expenses incurred solely as a result of running the extra classes. However, the principal has insisted that a 25% loading be added to the fee to go towards the college's day-to-day running costs. This is in accordance with the college's normal costing procedures.
	Give reasons why the principal's requirement may be inappropriate when costing the proposed evening class lectures.

Contribution

Variable cost restructuring

The media buying and market research company Aegis is proposing to cut 780 jobs across 40 countries. In talking to analysts and investors John Napier, the Chairman and interim chief executive, said that 2009 was likely to be a tougher year than 2008. As well as reducing staff by 5% by restructuring, Aegis is also proposing to bring variable costs such as incentives into line with 'a negative growth environment'.

Source: Adapted from www.ft.com/cms/s, 19 March 2009.

In order to illustrate what is meant by 'contribution' we will use a series of equations. The first is straightforward:

$$\text{sales revenue} - \text{total costs} = \text{profit (or loss)} \tag{1}$$

The second equation is based on the assumption that total costs can be analysed into variable costs and fixed costs:

$$\text{total costs} = \text{variable costs} + \text{fixed costs} \tag{2}$$

By substituting equation 2 into equation 1 we can derive equation 3:

$$\text{sales revenue} - (\text{variable costs} + \text{fixed costs}) = \text{profit (or loss)} \tag{3}$$

By rearranging equation 3 we can derive the following equation:

$$\text{sales revenue} - \text{variable costs} = \text{fixed costs} + \text{profit (or loss)} \tag{4}$$

Equation 4 is known as the *marginal cost equation*. We will simplify it by substituting symbols for words, namely sales revenue = S, variable costs = V, fixed costs = F, and profit = P (or loss = L). The equation now reads as follows:

$$S - V = F + P \tag{5}$$

But where does contribution fit into all of this? Contribution (C) *is the difference between the sales revenue and the variable costs of that sales revenue.* So, in equation form:

$$S - V = C \tag{6}$$

Contribution can also be looked at from another point of view. If we substitute C for $(S - V)$ in equation 5, the result will be:

$$C = F + P \tag{7}$$

In other words, contribution can be regarded as being either the difference between the sales revenue and the variable costs of that sales revenue or the total of fixed cost plus profit.

What do these relationships mean in practice and what is their importance? The meaning is reasonably straightforward. If an entity makes a contribution, it means that it has generated a certain amount of sales revenue and the variable cost of making those sales is less than the total sales revenue $(S - V = C)$. So there is a balance left over that can go towards contributing towards the fixed costs $(C - F)$; any remaining balance must be the profit $(C - F = P)$. Alternatively, if the contribution is insufficient to cover the fixed costs, the entity will have made a loss: $C - F = L$.

The importance of the relationships described above in equation format is important for two main reasons. First, fixed costs can often be ignored when taking a particular decision because, by definition, fixed costs will not change irrespective of whatever decision is taken. This means that any cost and revenue analysis is made much simpler. Second, managers can concentrate on decisions that will maximize the contribution, since every additional £1 of contribution is an extra amount that goes toward covering the fixed costs. Once the fixed costs have been covered then every extra £1 of contribution is an extra £1 of profit.

Activity 17.2	Company M's annual sales were £100,000, its variable costs £40,000 and its fixed costs £50,000.
	Calculate the profit for the year using the marginal cost equation.

Assumptions

The marginal cost technique used in contribution analysis is, of course, based on a number of assumptions. They may be summarized as follows:

- total costs can be split between fixed costs and variable costs;
- fixed costs remain constant irrespective of the level of activity;

- fixed costs do not bear any relationship to specific units;
- variable costs vary in direct proportion to activity.

The reliability of the technique depends very heavily on being able to distinguish between fixed and variable costs. Some costs may be semi-variable, i.e. they may consist of both a fixed and variable element. Electricity costs and telephone charges, for example, both contain a fixed rental element plus a variable charge. The variable charge depends on the units consumed or the number of telephone calls made. Such costs are relatively easy to analyse into their fixed and variable elements.

In practice, it may be difficult to split other costs into their fixed and variable components. The management accountants may need the help of engineers and work study specialists in determining whether a particular cost is fixed or variable. They may also have to draw on a number of graphical and statistical techniques. These techniques are somewhat advanced and beyond this book, so for our purposes we will assume that it is relatively easy to analyse costs into their fixed and variable components.

Activity 17.3	Reread the assumptions summarized above. Do you think that these assumptions are reasonable? Rank them in the order of how far you think that they are generally valid (1 = the most valid; 2 = the next most valid, and so on).

Format

In applying the marginal cost technique, the cost data are usually arranged in a vertical format on a line-by-line basis. The order of the data reflects the marginal cost equation $(S - V = F + P)$. This format enables the attention of managers to be directed towards the contribution that may arise from any particular decision. This is now called *contribution analysis*. The basic procedure is illustrated in Example 17.1.

Example 17.1	**A typical marginal cost statement**

	Symbol	Product A £000	B £000	C £000	Total £000
Sales revenue (1)	S	100	70	20	190
Less: variable costs of sales (2)	V	30	32	18	80
Contribution (3)	C	70	38	2	110
Less: fixed costs (4)	F				60
Profit (5)	P				50

Notes:

- The number in brackets after each item description refers to the tutorial notes below.
- The marginal cost equation is represented in the 'symbol' column, i.e. $S - V = C$; $C = F + P$; and thereby $S - V = F + P$.

Tutorial notes

1 The total sales revenue would normally be analysed into different product groupings. In this example there are three products: A, B and C.

2 The variable costs include direct materials, direct labour costs, other direct costs and variable overheads. Variable costs are assumed to vary *in direct proportion* to activity. Direct costs will normally be the same as variable costs, but in some cases this will not be so. A machine operator's salary, for example, may be fixed under a guaranteed annual wage agreement. It is a direct cost in respect of the machine but it is also a fixed cost because it will not vary with the number of units produced.

3 As explained above, the term *contribution* is used to describe the difference between the sales revenue and the variable cost of those sales. A positive contribution helps to pay for the fixed costs.

4 The fixed costs include all the other costs that do not vary in direct proportion to the sales revenue. Fixed costs are assumed to remain constant over a period of time. They do not bear any relationship to the units produced or the sales achieved. So it is not possible to apportion them to individual products. The *total* of the fixed costs can only be deducted from the *total contribution*.

5 The total contribution less the fixed costs gives the profit (if the balance is positive) or a loss (if the balance is negative).

Managers supplied with information similar to that contained in Example 17.1 may subject the information to a series of 'What if?' questions such as the following.

● What would the profit be if we increased the selling price of product A, B or C?
● What would be the effect if we reduced the selling price of product A, B or C?
● What would be the effect if we eliminated one or more of the products?
● What would happen if we changed the quality of any of the products so that the variable cost of each product either increased or decreased?
● Would any of the above decisions have an impact on fixed costs?

Activity 17.4

Rearrange the following data in a marginal cost format.

Annual rent £3000; direct labour £20,000; direct material £10,000; sales £75,000; staff salaries £47,000.

Application

News clip

Rentokil on the rise

Rentokil beat expectations as its first-half results were better than expected. It was reported that the 'washrooms to pest control business' made progress in cutting costs and improving productivity. This helped to double operating cash flows in the six months to June 2009. The City Link had, however, continued to make a loss but chief executive Alan Brown expected it to break even by the end of the year.

Source: Adapted from www.ft.com/cms/s, 1 August 2009.

As we have seen, the basic assumptions used in marginal costing are somewhat simplistic. In practice, they would probably only be regarded as appropriate when a particular decision was first considered. Thereafter each of the various assumptions would be rigorously tested and they would be subject to a number of searching questions such as: 'If we change the selling price of this product, will it affect the sales of the other products?' 'Will variable costs always remain in direct proportion to activity?' or 'Will fixed costs remain fixed irrespective of the level of activity?'

We will now use a simple example to illustrate the application of the technique. The details are shown in Example 17.2. This illustrates the effect of a change in variable costs on contribution.

Example 17.2	**Changes in the variable cost**				
		One unit	*Proportion*	*100 units*	*1000 units*
		£	%	£	£
	Sales revenue	10	100	1000	10 000
	Less: variable costs	5	50	500	5 000
	Contribution	5	50	500	5 000

Tutorial notes to Example 17.2

1 The selling price per unit is £10, and the variable cost per unit is £5 (50 per cent of the selling price). The contribution, therefore, is also £5 per unit (50 per cent of the selling price).

2 These relationships are assumed to hold good no matter how many units are sold. So if 100 units are sold the contribution will be £500; if 1000 units are sold there will be a contribution of £5000, i.e. the contribution is assumed to remain at 50 per cent of the sales revenue.

3 The fixed costs are ignored because it is assumed that they will *not* change as the level of activity changes.

Every extra unit sold will increase the profit by £5 per unit *once the fixed costs have been covered* – an important qualification. This point is illustrated in Example 17.3.

Example 17.3	**Changes in profit at varying levels of activity**					
	Activity (units)	*1000*	*2000*	*3000*	*4000*	*5000*
		£	£	£	£	£
	Sales	10 000	20 000	30 000	40 000	50 000
	Less: variable costs	5 000	10 000	15 000	20 000	25 000
	Contribution	5 000	10 000	15 000	20 000	25 000
	Less: fixed costs	10 000	10 000	10 000	10 000	10 000
	Profit/(Loss)	(5 000)	–	5 000	10 000	15 000

Tutorial notes to Example 17.3

1 The exhibit illustrates five levels of activity: 1000 units, 2000 units, 3000 units, 4000 units and 5000 units.

2 The variable costs remain directly proportional to activity at all levels, i.e. 50 per cent. The contribution is, therefore, 50 per cent (100% – 50%). The contribution per unit may be obtained by dividing the contribution at any level of activity level by the activity at that level, e.g. at an activity level of 1000 units the contribution per unit is £5 (£5000 ÷ 1000).

*Tutorial notes
to Example 17.3
continued*

3 The fixed costs do not change, irrespective of the level of activity.

4 The contribution needed to cover the fixed costs is £10,000. As each unit makes a contribution of £5, the total number of units needed to be sold in order to break even, i.e. to reach a point where sales revenue equals the total of both the variable and the fixed costs, will be 2000 (£10,000 ÷ £5).

5 When *more* than 2000 are sold, the increased contribution results in an increase in profit. So, when 3000 units are sold instead of 2000, for example, the increased contribution is £5000 (£15,000 – 10,000); the increased profit is also £5000 (£5000 – 0). Similarly, when 4000 units are sold instead of 3000, the increased contribution is another £5000 (£20,000 – 15,000) and the increased profit is also £5000 (£10,000 – 5000). Finally, when 5000 units are sold instead of 4000 units, the increased contribution is once more £5000 (£25,000 – 20,000), as is the increased profit (£15,000 – 10,000).

6 The relationship between contribution and sales is known (rather confusingly) as the *profit/volume* (or P/V) ratio. Note that it does not mean *profit* in relationship to sales but the *contribution* in relationship to sales.

7 Assuming that the P/V ratio does not change, we can quickly calculate the profit at any level of sales. All we need to do is to multiply the P/V ratio by the sales revenue and then deduct the fixed costs. The balance will then equal the profit at that level of sales. It is also easy to accommodate any possible change in fixed costs if the activity level moves above or below a certain range.

Example 17.2 and Example 17.3 are simple examples but we hope that they demonstrate just how useful contribution analysis can be in managerial decision making. While the basic assumptions may be somewhat questionable, they can readily be adapted to suit more complex problems.

Activity 17.5

You are presented with the following data: number of units sold 5000, sales revenue £50,000, variable costs £25,000, fixed costs £10,000.

If the company wanted to make the same amount of profit, how many units would have to be sold if the fixed costs rose to £15,000?

Charts and graphs

Contribution analysis lends itself to the presentation of information in a pictorial format. Indeed, the $S - V = F + P$ relationship is often easier to appreciate when it is reported to managers graphically.

The most common format is in the form of what is called a *break-even chart*. A break-even chart is illustrated in Example 17.4. The chart is based on the data used in Example 17.3.

Example 17.4 shows quite clearly the relationships that are assumed to exist when the marginal costing technique is adopted. Sales revenue, total costs and fixed costs are all assumed to be linear, so they are all drawn as straight lines. Note also the following points.

● When no units are sold, the sales revenue line runs from the origin up to £50,000 when 5000 units are sold. It may then continue as a straight line beyond that point.
● The total cost line is made up of both the fixed costs and the variable costs. When there is no activity the total costs will be equal to the fixed costs, so the total cost line runs from the fixed cost point of £10,000 up to £35,000 when 5000 units are sold. It may then continue beyond that point.

- The fixed cost line is drawn from the £10,000 point as a straight line parallel to the x axis irrespective of the number of units sold.

In practice, the above relationships are not likely to hold good over the range of activity indicated in the example. They are usually assumed to remain valid over only a small range of activity. This is known as the *relevant range*. In this example the relevant range may be from (say) 1000 to 3000 units. Above or below these levels the selling prices, the variable costs and the fixed costs may all change.

While this point might appear to create some difficulty, it should be appreciated that wide fluctuations in activity are not normally experienced. It is usually quite reasonable to assume that the entity will be operating in a fairly narrow range of activity and that the various relationships will be linear. It must also be remembered that the information is meant to be only a *guide* to managerial decision making and that it is impossible to be absolutely precise.

Example 17.4	A break-even chart
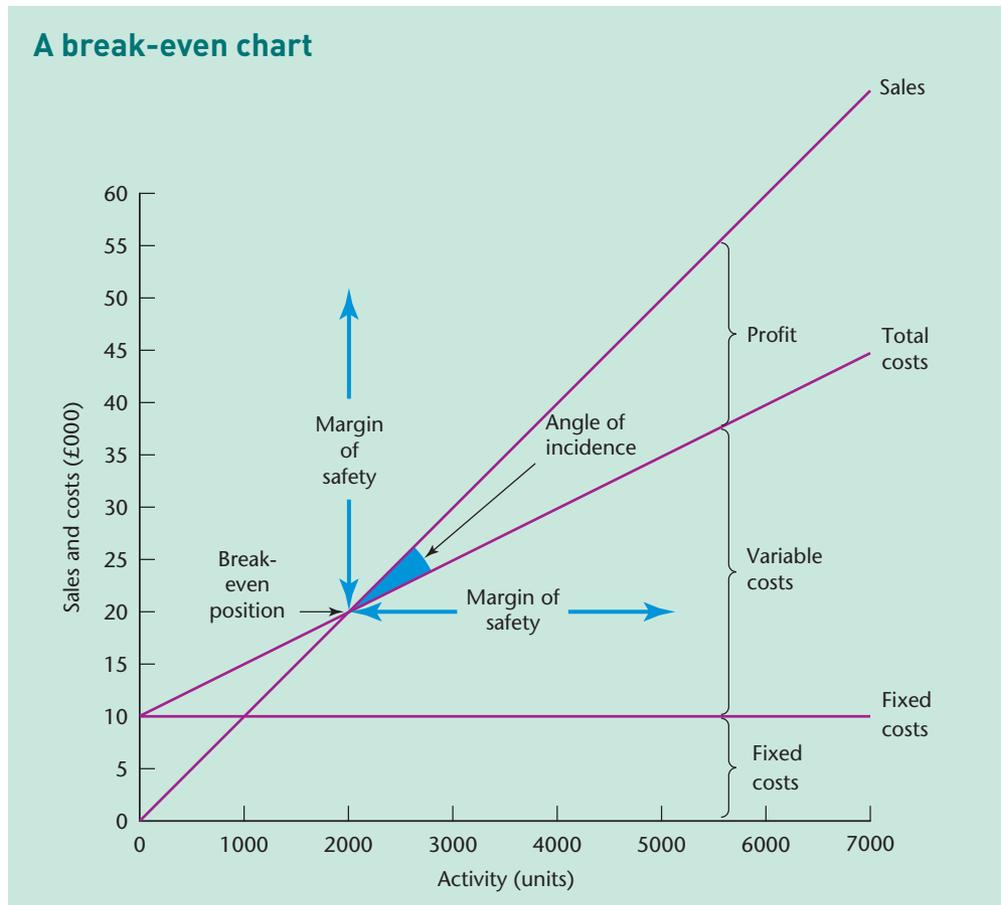
Tutorial notes to Example 17.4

1 The total costs line is a combination of the fixed costs and the variable costs. So it ranges from a total cost of £10,000 (fixed costs only) at a nil level of activity, to £35,000 when the activity level is 5000 units (fixed costs of £10,000 + variable costs of £25,000).

2 The angle of incidence is the angle formed between the sales line and the total cost line. The wider the angle, the greater the amount of profit. A wide angle of incidence and a wide margin of safety (see note 3) indicates a highly profitable position.

Tutorial notes to Example 17.4 continued

3 The margin of safety is the distance between the sales achieved and the sales level needed to break even. It can be measured either in units (along the *x* axis of the graph) or in sales revenue terms (along the *y* axis).

4 Activity (measured along the *x* axis) may be measured either in units or as a percentage of the theoretical maximum level of activity, or in terms of sales revenue.

You will see that the break-even chart shown in Example 17.4 does not show a separate variable cost line. This may be somewhat confusing, and so sometimes the information is presented in the form of a *contribution graph.* A contribution graph based on the data used in Example 17.4 is illustrated in Example 17.5. Can you spot the differences between the two examples?

Example 17.5

A contribution graph
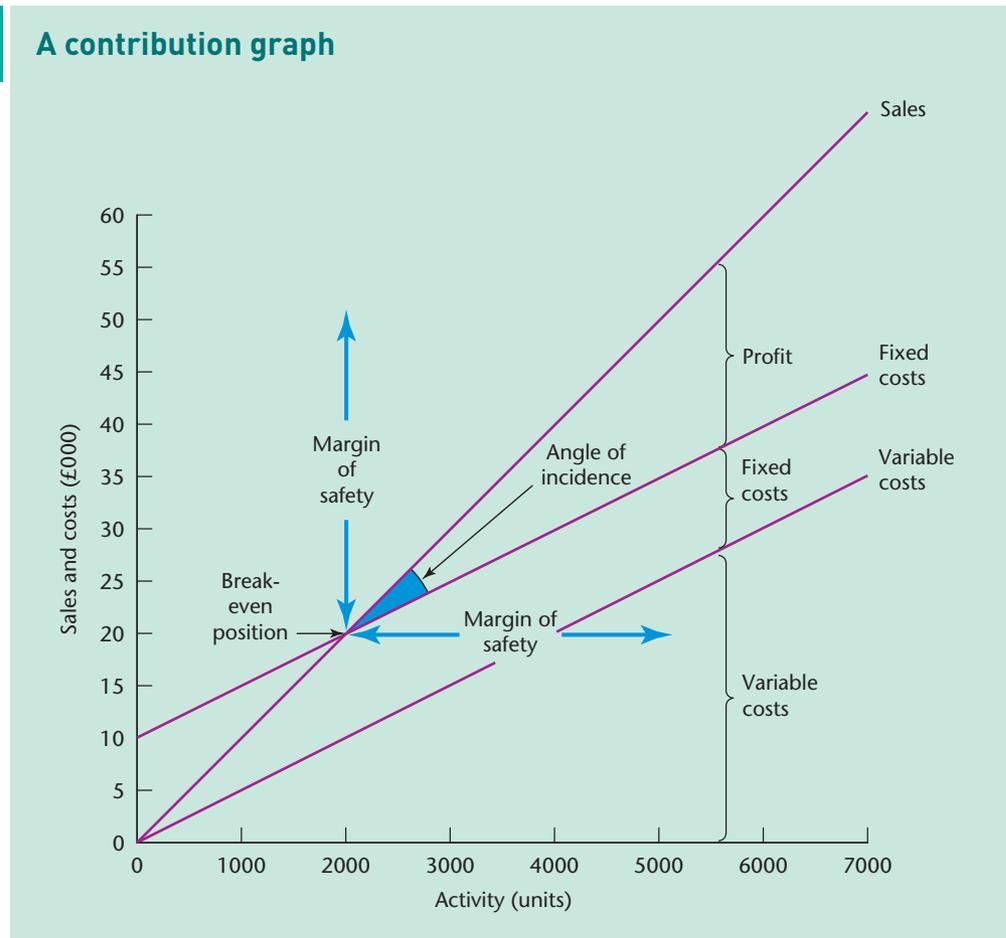
- The contribution graph shows the variable cost line ranging from the origin when there is no activity to £25,000 when 5000 units are sold. It then continues beyond that point in a straight line.
- The fixed cost line is drawn parallel to the variable cost line, i.e. higher up the *y* axis. As the fixed costs are assumed to remain fixed irrespective of the level of activity, the fixed cost line runs from £10,000 when there is no activity to £35,000 when 5000 units are sold. It is then continued as a straight line beyond that point.
- The fixed cost line also serves as the total cost line.

Apart from the above differences, the break-even chart and the contribution graph are identical. Which one should you adopt? There is no specific guidance that we can give since the decision is one largely of personal preference. The break-even chart is more common, but the contribution chart is probably more helpful since the fixed and the variable cost lines are shown separately.

One problem with both the break-even chart and the contribution graph is that neither shows the *actual amount of profit or loss* at varying levels of activity. So, if you wanted to know what the profit was when (say) 4000 units were sold, you would have to use a ruler to measure the distance between the sales line and the total cost line. This is not very satisfactory so in order to get over this problem we can use a *profit/volume chart* (or graph).

A profit/volume chart shows the effect of a change in activity on profit. An example of such a chart is shown in Example 17.6. It is based on the data used in Example 17.3.

Example 17.6

A profit/volume chart
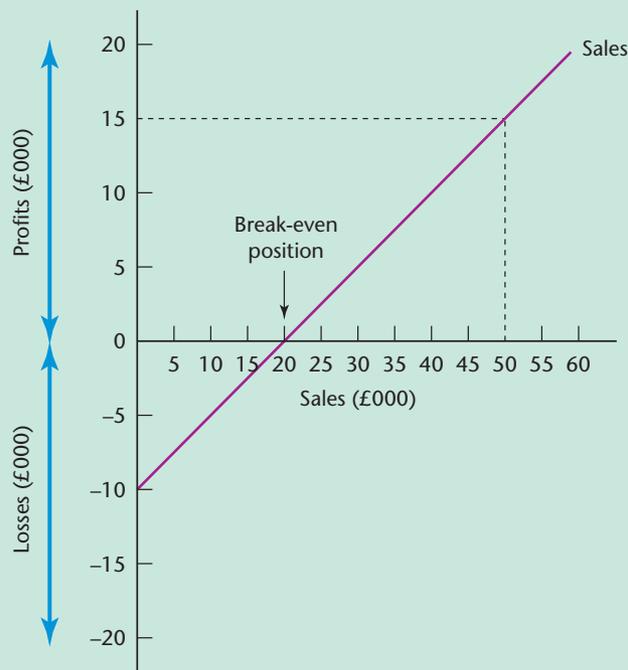
Tutorial notes to Example 17.6

1 The *x* axis can be represented either in terms of units, as a percentage of the activity level or in terms of sales revenue.

2 The *y* axis represents profits (positive amounts) or losses (negative amounts).

3 With sales at a level of £50,000, the profit is £15,000. The sales line cuts the *x* axis at the break-even position of £20,000 sales. If there are no sales, the loss equals the fixed costs of £10,000.

As you can see from Example 17.6 the profit/volume chart only shows the entity's *total* profit or loss. It does not show the profit or loss made on individual products. It is possible to do so although the result is somewhat simplistic (see Example 17.7).

Example 17.7

Tilsy Limited

You are presented with the following information.

Product	A	B	C	Total
	£	£	£	£
Sales	5 000	20 000	25 000	50 000
Less: variable costs	3 000	10 000	12 000	25 000
Contribution	2 000	10 000	13 000	25 000
Less: fixed costs				10 000
Profit				15 000

Additional information:
Assume that Tilsy first began manufacturing and selling Product A, then Product B, and finally Product C. Its fixed costs remained constant at £10,000 irrespective of whether it was dealing with one, two or all three of these products.

Required:
Prepare a profit/volume chart showing the impact on its profit/(loss) of the individual product ranges.

Answer to Example 17.7
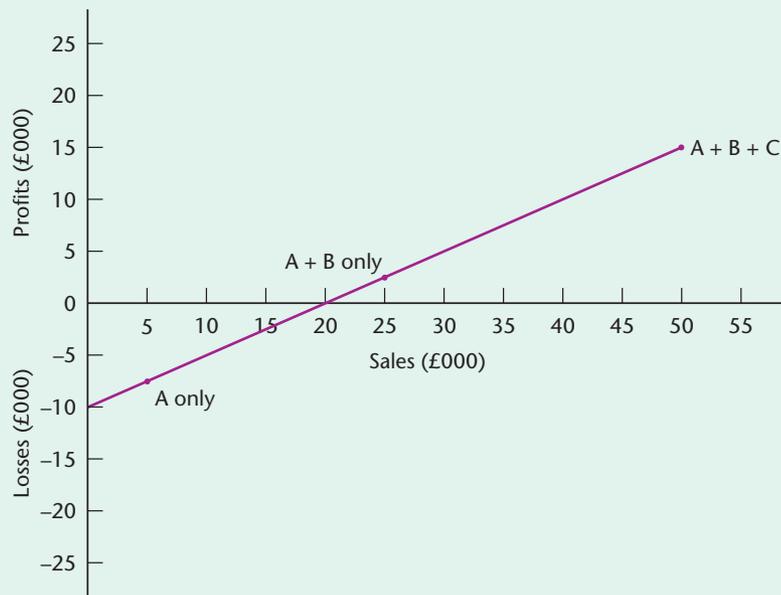
1 If Product A is the first product, the company makes a loss of £8000 (£2000 – 10,000). Once Product B is introduced a profit of £2000 is made [(£2000 + 10,000) – 10,000]. Then when Product C is added the profit becomes £15,000 [(£2000 + 10,000 + 13,000) – 10,000].

2 It would be possible to plot the three product ranges in a different order, e.g. Product B, then Product C, then Product A; or possibly Product C, then Product A, then Product B.

3 The disclosure of the impact of individual products on profit is useful because it can highlight the performance of a poorly performing product. Product A does make a small contribution of £2000 (£5000 – 3000) but this is not sufficient to offset the fixed costs of £10,000. It is only when Product B is introduced that the company begins to make a profit. The chart shows this fairly clearly.

Activity 17.6

On a scale of 1 to 5, how useful do you think that the following diagrams are to management (5 = very useful; 1 = not at all useful)?

(a) a break-even chart ☐

(b) a contribution graph ☐

(c) a profit/volume chart ☐

Reservations

The assumptions adopted in preparing marginal cost statements and their use in contribution analysis lead to a number of important reservations about the technique. The main ones are as follows.

- *Cost classification.* Costs cannot be easily divided into fixed and variable categories.
- *Variable costs.* Variable costs do not necessarily vary in direct proportion to sales revenue at all levels of activity. The cost of direct materials, for example, may change if supplies are limited or if they are bought in bulk. It is also questionable whether direct labour should be treated as a variable cost (as is often the case) since current legislative practice makes it difficult to dismiss employees at short notice.
- *Fixed costs.* Fixed costs are unlikely to remain constant over a wide range of activity. There is a good chance that they will change both beyond and below a fairly narrow range. They may perhaps move in 'steps', so that between an activity level of 0 and 999 units, for example, the fixed costs may be £10,000, be £12,000 between an activity level of 1000 and 2999 units, be £15,000 between an activity level of 3000 and 5000 units, and so on.
- *Time period.* The determination of the time period over which the relationship between the fixed and variable costs may hold good is difficult to determine. In the very short term (say a day), all costs may be fixed. In the long term (say five years), all costs may be variable as the entity could go out of business.
- *Complementary products.* A specific decision affecting one product may affect other products. For example, a garage sells both petrol and oil. A decision to stop selling oil may affect sales of petrol.
- *Cost recovery.* It may be unwise to exclude fixed costs altogether from the analysis. In the medium-to-long term an entity must recover all of its costs. Decisions cannot be taken purely in terms of the impact that they may have on contribution.
- *Diagrammatic presentations.* Break-even charts, contribution graphs and profit/volume charts are somewhat simplistic. The sales of individual products are considered in total and it is assumed that any change made to one product will have a proportionate effect on all the other products.
- *Non-cost factors.* Decisions cannot be taken purely on the basis of cost. Sometimes factors that cannot be easily quantified and costed are more important, e.g. comfort, convenience, loyalty, reliability or speed.
- *Behavioural factors.* In practice, behavioural factors also have to be considered. Individuals do not always act rationally and an actual behaviour pattern may be quite different from what was expected. A decrease in the selling price of a product, for

example, may reduce the quantity of good purchased because it is *perceived* to be of poor quality.

The factors listed above are all fairly severe reservations of the marginal costing technique and its use in contribution analysis. Nevertheless, experience suggests that it has still a useful part to play in managerial decision making, provided that the basis on which the information is built is understood, its apparent arithmetical precision is not regarded as a guarantee of absolute certainty, and non-cost factors are also taken into account.

With these reservations in mind, we can now move on to look at the technique in a little more detail. Before we do so, however, it would be useful to summarize the main formulae so that it will be easier for you to refer back to them when dealing with the various examples.

Activity 17.7 Reread the reservations outlined above. Judging them from a non-accountant's point of view, select the three most significant weaknesses of the marginal costing approach and summarize them.

Formulae

Earlier in the chapter we explained that marginal costing revolves around the assumption that total costs can be classified into fixed and variable costs. This then led us on to an explanation of what we called the *marginal cost equation*, i.e. $S - V = F + P$. This equation can be used as the basis for a number of other simple equations that are useful in contribution analysis. The main ones are summarized below.

Abbreviation:

- Sales – variable cost of sales = contribution 　　　　　　 $S - V = C$

- Contribution – fixed costs = profit/(loss) 　　　　　　 $C - F = P/(L)$

- Break-even (B/E) point = contribution – fixed costs 　　 $C - F$

- B/E in sales value terms = $\dfrac{\text{fixed costs} \times \text{sales}}{\text{contribution}}$ 　　 $\dfrac{F \times S}{C}$

- B/E in units = $\dfrac{\text{fixed costs}}{\text{contribution per unit}}$ 　　 $\dfrac{F}{C \text{ per unit}}$

- Margin of safety (M/S) in sales value terms = $\dfrac{\text{profit} \times \text{sales}}{\text{contribution}}$ 　　 $\dfrac{P \times S}{C}$

- M/S in units = $\dfrac{\text{profit}}{\text{contribution per unit}}$ 　　 $\dfrac{P}{C \text{ per unit}}$

Example 17.8 illustrates the use of some of these formulae.

<table>
<tr><td>**Example 17.8**</td><td>

The use of the marginal cost formulae

The following information relates to Happy Limited for the year to 30 June 2012.

</td></tr>
</table>

Number of units sold: 10,000

	Per unit	Total
	£	£000
Sales	30	300
Less: Variable costs	18	180
Contribution	12	120
Less: Fixed costs		24
Profit		96

Required:
In value and unit terms, calculate the following:
(a) the break-even position
(b) the margin of safety.

Answer to Example 17.8

(a) Break-even position in value terms:

$$\frac{F \times S}{C} = \frac{£24\,000 \times 300\,000}{120\,000} = £60\,000$$

Break-even in units:

$$\frac{F}{C \text{ per unit}} = \frac{£24\,000}{12} = 2000 \text{ units}$$

(b) Margin of safety in value terms:

$$\frac{P \times S}{C} = \frac{£96\,000 \times 300\,000}{120\,000} = £240\,000$$

Margin of safety in units:

$$\frac{P}{C \text{ per unit}} = \frac{£96\,000}{12} = 8000 \text{ units}$$

Tutorial note

Note the relationship between the sales revenue and the margin of safety. The sales revenue is £300,000 and £60,000 of sales revenue is required to break even. The margin of safety is, therefore, £240,000 (£300,000 – 60,000).

Activity 17.8

Using the data in Example 17.8 prepare (a) a break-even chart; and (b) a profit/volume chart.

It would now be helpful to incorporate the principles behind contribution analysis into a simple example. Example 17.9 outlines a typical problem that a board of directors might well face.

Example 17.9	**Marginal costing**

Looking ahead to the financial year ending 31 March 2012, the directors of Problems Limited are faced with a budgeted loss of £10,000. This is based on the following data.

Budgeted number of units: 10,000

	£000
Sales revenue	100
Less: Variable costs	80
Contribution	20
Less: Fixed costs	30
Budgeted loss	(10)

The directors would like to aim for a profit of £20,000 for the year to 31 March 2012. Various proposals have been put forward, none of which require a change in the budgeted level of fixed costs. These proposals are as follows:

1 Reduce the selling price of each unit by 10 per cent.
2 Increase the selling price of each unit by 10 per cent.
3 Stimulate sales by improving the quality of the product, which would increase the variable cost of the unit by £1.50 per unit.

Required:
(a) For each proposal calculate:
    (i)   the break-even position in units and in value terms;
    (ii) the number of units required to be sold in order to meet the profit target.
(b) State which proposal you think should be adopted.

Answer to Example 17.9

Problems Limited
(a) (i) and (ii)

Workings:	£
Profit target	20 000
Fixed costs	30 000
Total contribution required	50 000

The budgeted selling price per unit is £10 (£100 000/10 000). The budgeted variable cost per unit is £8 (£80 000/10 000).

The budgeted outlook compared with each proposal may be summarized as follows:

Per unit:	*Budgeted position*	*Proposal 1*	*Proposal 2*	*Proposal 3*
	£	£	£	£
Selling price	10	9	11	10.00
Less: Variable costs	8	8	8	9.50
(a) Unit contribution	2	1	3	0.50
(b) Total contribution required to break even (= fixed costs) (£)	30 000	30 000	30 000	30 000

(c) Total contribution required to
meet the profit target (£)

Total contribution required to meet the profit target (£)	50 000	50 000	50 000	50 000
Number of units to break even [(b)/(a)]	15 000	30 000	10 000	60 000
Number of units to meet the profit target [(c)/(a)]	25 000	50 000	16 667	100 000

(b) Comments

1 By continuing with the present budget proposals, the company would need to sell 15,000 units to break even or 25,000 units to meet the profit target. So in order to break even the company needs to increase its unit sales by 50% $\left(\dfrac{£15\,000 - 10\,000}{10\,000} \times 100 \right)$ and by 150% $\left(\dfrac{£25\,000 - 10\,000}{10\,000} \times 100 \right)$ to meet the profit target.

2 A reduction in selling price of 10% per unit would require unit sales to increase by 200% $\left(\dfrac{£30\,000 - 10\,000}{10\,000} \times 100 \right)$ in order to break even and by 400% $\left(\dfrac{£50\,000 - 10\,000}{10\,000} \times 100 \right)$ to meet the profit target.

3 By increasing the selling price of each unit by 10%, the company would only have to sell at the budgeted level to break even, but its unit sales would have to increase by 66.7% $\left(\dfrac{£16\,667 - 10\,000}{10\,000} \times 100 \right)$ to meet the profit target.

4 By improving the product at an increased variable cost of £1.50 per unit, the company would require a 500% $\left(\dfrac{£60\,000 - 10\,000}{10\,000} \times 100 \right)$ increase in unit sales to break even, or a 900% $\left(\dfrac{£100\,000 - 10\,000}{10\,000} \times 100 \right)$ increase to meet the profit target.

Conclusion

It would appear that increasing the selling price by 10% would be a more practical solution for the company to adopt. In the short run, at least, it will break even and there is the possibility that sales could be sufficient to make a small profit. In the long run this proposal has a much better chance of meeting the profit target than do the other proposals. Some extra stimulus would be needed, however, to lift sales to this level over such a relatively short period of time. It is not clear why an increase in price would increase sales, unless the product is one that only sells at a comparatively high price, such as cosmetics and patent medicines. It must also be questioned whether the cost relationships will remain as indicated in the example over such a large increase in activity. In particular, it is unlikely that the fixed costs will remain entirely fixed if there were to be a 66.7% increase in sales.

Limiting factors

When optional decisions are being considered, the aim will always be to maximize contribution because the greater the contribution then the more chance there is of covering the fixed costs and of making a profit. When managers are faced with a choice, therefore,

between (say) producing product A at a contribution of £10 per unit or of producing product B at a contribution of £20 per unit, they would normally choose product B. Sometimes, however, it may not be possible to produce unlimited quantities of product B because there could be limits on how many units could either be sold or produced. Such limits are known as *limiting factors* (or key factors).

Limiting factors may arise for a number of reasons. It may not be possible, for example, to sell more than a certain number of units, there may be production restraints (such as shortages of raw materials, skilled labour or factory space), or the company may not be able to finance the anticipated rate of expansion.

If there is a product that cannot be produced and sold in unlimited quantities, then it is necessary to follow a simple rule in order to decide which product to concentrate on producing. The rule can be summarized:

> **choose the work that provides the maximum contribution per unit of limiting factor employed.**

This sounds very complicated but it is easy to apply in practice. In outline, the procedure is as follows (we will assume that direct labour hours are in short supply).

1 Calculate the contribution made by each product.
2 Divide the contribution that each product makes by the number of direct labour hours used in making each product.
3 This gives the contribution per direct labour hour employed (i.e. the limiting factor).
4 Select the project that gives the highest contribution per unit of limiting factor.

So if we had to choose between two jobs, say A and B, we would convert A's contribution and B's contribution into the amount of contribution earned for every direct labour hour worked on A and on B respectively. We would then opt for the job that earned the most contribution per direct labour hour. The technique is illustrated in Example 17.10.

Example 17.10	**Application of key factors**

Quays Limited manufactures a product for which there is a shortage of the raw material known as PX. During the year to 31 March 2012, only 1000 kilograms of PX will be available. PX is used by Quays in manufacturing both product 8 and product 9. The following information is relevant:

Per unit:	Product 8	Product 9
	£	£
Selling price	300	150
Less: Variable costs	200	100
Contribution	100	50
P/V ratio $\left(\dfrac{£100}{300} \times 100\right)$ and $\left(\dfrac{£50}{150} \times 100\right)$	$33\frac{1}{3}$	$33\frac{1}{3}$
Kilograms of PX required	5	2

Required:
State which product Quays Limited should concentrate on producing.

Answer to Example 17.10

	Product 8 £	Product 9 £
Contribution per unit	100	50
Limiting factor per unit (kg)	÷ 5	÷ 2
Contribution per kilogram	= 20	= 25

Decision:
Quays should concentrate on product 9 because it gives the highest contribution per unit of limiting factor.

Check:
Maximum contribution of product 8:

200 units (1000kg/5) × contribution per unit = 200 × £100 = £20 000

Maximum contribution of product 9:

500 units (1000kg/2) × contribution per unit = 500 × £50 = £25 000

In Example 17.10 it was assumed that there was only one limiting factor, but there could be many more. This situation is illustrated in Example 17.11. The basic data are the same as for Example 17.10.

Example 17.11

Marginal costing using two key factors

Information:
1 Assume now that it is not possible for Quays Limited to sell more than 400 units of product 9.
2 The company would aim to sell all of the 400 units because product 9's contribution per unit of limiting factor is greater than product 8's. The total contribution would then be £20,000 (400 × £50).
3 The 400 units would consume 800 units of raw materials (400 × 2 kilograms), leaving 200 (1000 – 800) kilograms for use in producing product 8.
4 Product 8 requires 5 kilograms per unit of raw materials, so 40 units (200kg ÷ 5kg) could be completed at a total contribution of £4000 (40 × £100).

Summary of the position:

	Product 8	Product 9	Total
Units sold	40	400	
Raw materials (kilograms used)	200	800	1 000
Contribution per unit (£)	100	50	
Total contribution (£)	4 000	20 000	24 000

Note: The £24,000 total contribution compares with the contribution of £25,000 that the company could have made if there were no limiting factors affecting the sales of product 9.

Activity 17.9

A few examples of limiting factors are given in the text. Make a list of them. Now think about the concept. An entity will choose to make and sell as many units as it can of those products that make the highest contribution per unit of limiting factor. What other specific factors might stop it from doing so? Add them to your list.

> **⚠ Questions you should ask**
>
> When you have a specific decision to take as a manager, it is almost certain that your accountants will do the detailed calculative work for you. They are likely to present you with a summary of their results and their recommendations.
>
> We will assume that you have asked them for some guidance on a specific decision that you have to take. What should you ask them when you receive the information? The following questions are suggested, although you will, of course, need to adapt them depending on the circumstances.
>
> - Where have you got the basic data from?
> - What estimates have you had to make in adapting the original data?
> - Has the information been compiled on a contribution basis?
> - If not, why not? What other method have you used? Why is the contribution approach not appropriate in this case?
> - If the contribution approach has been used, how have the variable costs been separated from the fixed costs?
> - Have you assumed that variable costs move in direct proportion to sales revenue?
> - Over what timescale are the fixed costs fixed?
> - Over what time period will the various cost relationships last?
> - What impact will your recommendations have on other aspects of the business?
> - What non-quantifiable factors have you been able to take into account?
> - What non-quantifiable factors have been ignored?
> - Generally, how reliable is the information that you have given me?
> - What confidence can I have in it?
> - Is there anything else that I should know?

Conclusion

Contribution analysis is particularly useful in short-term decision making but it is of less value when decisions have to be viewed over the long term. The system revolves around two main assumptions:

- some costs remain fixed irrespective of the level of activity;
- other costs vary in direct proportion to sales.

These assumptions are not valid over the long term but provided that they are used with caution then they can be adopted usefully in the short term.

It should also be remembered that the technique is only a *guide* to decision making and that non-cost factors have to be taken into account.

In the next chapter we use contribution analysis to deal with other managerial problems.

Key points	
	1 Total cost can be analysed into fixed costs and variable costs.
	2 Fixed costs are assumed to be unrelated to activity. They may be ignored in making short-term managerial decisions.
	3 A company will aim to maximize the *contribution* that each unit makes to profit.
	4 The various relationships between costs can be expressed in the form of an equation: $S - V = F + P$, where S = sales, V = variable costs, F = fixed costs and P = profit.
	5 It may not always be possible to maximize unit contribution because materials, labour, finance or other factors may be in short supply.
	6 In the long run, fixed costs cannot be ignored.

Check your learning

The answers to these questions can be found within the text.

1 What system of costing is normally used for the costing of products and for stock valuation purposes?

2 Why is this system not suitable for specific decision making?

3 What is meant by 'decision making'?

4 What term is given to the extra cost of an event?

5 What is meant by 'incremental costing'?

6 What is (a) a fixed cost, (b) a variable cost?

7 What is meant by the term 'contribution'?

8 What is the marginal cost equation?

9 List four main assumptions that underpin marginal costing.

10 What is a break-even chart?

11 What is meant by the terms (a) 'break-even', (b) 'angle of incidence', (c) 'margin of safety'?

12 What is a contribution graph?

13 What is a profit/volume chart?

14 List six assumptions that are adopted when preparing a marginal cost statement.

15 What is the formula for calculating (a) the break-even position in sales value terms, (b) the break-even position in units, (c) the margin of safety in sales value terms, (d) the margin of safety in units?

16 What is meant by a 'limiting factor'?

17 Give three examples of limiting factors.

18 State the rule that is used when activity is restricted by the presence of a limiting factor.

News story quiz

Remember that news story at the beginning of this chapter? Go back to that story and reread it before answering the following questions.

This is yet another story of a company struggling to break even still less make a profit during a deep recession. The story is of particular interest to us because it illustrates the concept of break-even that we have outlined in this chapter. It makes the point for us that when trading conditions are difficult a company may strive merely to 'break even' by cutting costs. And in case we sometimes forget, cutting costs usually means that employees lose their jobs – often with tragic consequences.

Questions

1 What do you think Mr Verwaayen means by the phrase 'expected to hit its target of break-even at the level of adjusted operating income'?

2 Is it possible to break even by any other means?

3 How would a one-off tax-free gain on the sale of Thales affect Alcatel-Lucent's break-even position?

Tutorial questions

The answers to questions marked with an asterisk can be found in Appendix 4.

17.1 'It has been suggested that although contribution analysis is fine in theory, fixed costs cannot be ignored in practice.' Discuss this statement.

17.2 'Contribution analysis described in textbooks is too simplistic and is of little relevance to management.' How far do you agree with this statement?

17.3 Do break-even charts and profit graphs help management to make more meaningful decisions?

17.4* The following information relates to Pole Limited for the year to 31 January 2012.

	£000
Administration expenses:	
Fixed	30
Variable	7
Semi-variable (fixed 80%, variable 20%)	20
Materials:	
Direct	60
Indirect	5
Production overhead (all fixed)	40
Research and development expenditure:	
Fixed	60
Variable	15
Semi-variable (fixed 50%, variable 50%)	10
Sales	450

Selling and distribution expenditure:	
Fixed	80
Variable	4
Semi-variable (fixed 70%, variable 30%)	30
Wages:	
Direct	26
Indirect	13

Required:
Using the above information, compile a contribution analysis statement for Pole Limited for the year to 31 January 2012.

17.5* You are presented with the following information for Giles Limited for the year to 28 February 2012:

	£000
Fixed costs	150
Variable costs	300
Sales (50 000 units)	500

Required:
(a) Calculate the following:
  (i) the break-even point in value terms and in units
  (ii) the margin of safety in value terms and in units.
(b) Prepare a break-even chart.

17.6 The following information applies to Ayre Limited for the two years to 31 March 2011 and 2012 respectively:

Year	Sales	Profits
	£000	£000
31.3.2011	750	100
31.3.2012	1 000	250

Required:
Assuming that the cost relationships had remained as given in the question, calculate the company's profit if the sales for the year to 31 March 2012 had reached the budgeted level of £1,200,000.

17.7 The following information relates to Carter Limited for the year to 30 April 2012:

Units sold: 50,000	
Selling price per unit	£40
Net profit per unit	£9
Profit/volume ratio	40%

During 2013 the company would like to increase its sales substantially, but to do so it would have to reduce the selling price per unit by 20 per cent. The variable cost per unit will not change, but because of the increased activity the company will have to invest in new machinery which will increase the fixed costs by £30,000 per annum.

Required:
Given the new conditions, calculate how many units the company will need to sell in 2013 in order to make the same amount of profit as it did in 2012.

17.8 Puzzled Limited would like to increase its sales during the year to 3l May 2012. To do so, it has several mutually exclusive options open to it:

- reduce the selling price per unit by 15 per cent;
- improve the product resulting in an increase in the variable cost per unit of £1.30;

● spend £15,000 on an advertising campaign;
● improve factory efficiency by purchasing more machinery at a fixed extra annual cost of £22,500.

During the year to 31 May 2011, the company sold 20,000 units. The cost details were as follows:

	£000
Sales	200
Variable costs	150
Contribution	50
Fixed costs	40
Profit	10

These cost relationships are expected to hold in 2012.

Required:
State which option you would recommend and why.

17.9 The following information relates to Mere's budget for the year to 31 December 2012:

	Product			
	K	L	M	Total
	£000	£000	£000	£000
Sales	700	400	250	1350
Direct materials	210	60	30	300
Direct labour	100	200	200	500
Variable overhead	90	60	50	200
Fixed overhead	20	40	40	100
	420	360	320	1100
Profit/(loss)	280	40	(70)	250
Budgeted sales (units)	140	20	25	

Note: Fixed overheads are apportioned on the basis of direct labour hours.

The directors are worried about the loss that product M is budgeted to make and various suggestions have been made to counteract the loss, viz.:

● stop selling product M;
● increase M's selling price by 20 per cent;
● reduce M's selling price by 10 per cent;
● reduce its costs by purchasing a new machine costing £350,000, thereby decreasing the direct labour cost by £100,000 (the machine would have a life of five years; its residual value would be nil).

Required:
Evaluate each of these proposals.

Further practice questions, study material and links to relevant sites on the World Wide Web can be found on the website that accompanies this book. The site can be found at **www.pearsoned.co.uk/dyson**