Break-even analysis

Break-even analysis (or, to be more correct, cost-volume-profit analysis) is a simple but very useful aid to decision making within business. It can be employed to discover the level of output that is required before profits are made, as well as the level of output required to produce a certain level of profits.

**Chapter objectives**

1. To develop an understanding of break-even analysis.
2. To enable readers to calculate break-even output, margin of safety and profits by graphical and numerical means.
3. To develop an understanding of the limitations of this technique.

**The break-even graph**

As we discovered in Chapter 32, costs can be divided into variable costs (such as materials, fuel and labour costs) and fixed costs (such as rent and interest charges). Variable costs rise and fall with output whereas fixed costs remain the same irrespective of output. For the purpose of analysis, we will assume that there is a linear or straight line relationship between costs and output and, separately, revenue output. Suppose fixed costs amount to £200,000 and variable costs are £1 per unit. At zero output, total costs will be £200,000. At an output of 100,000, total costs will rise to £200,000, plus £1 \times 100,000 equals £300,000. This can be shown graphically (see Figure 33.1). Fixed costs are represented by a horizontal line (as they are the same irrespective of output) whereas variable costs are superimposed on top. As output rises, variable costs (and, therefore, total costs) also rise. The vertical distance between total costs and fixed costs is the variable cost at each level of output.

Total revenue (TR) can be calculated by multiplying price by the quantity sold. Hence, if the price is £4 per unit and 100,000 units are sold, total revenue is £400,000. The total revenue line rises from the point of origin. As we are assuming a linear relationship, it is only necessary to plot two points that can then be connected with a straight line.

Where the total cost and total revenue curves
cross the product is neither making a profit nor a loss. It is in fact at the **break-even level of output**. If, for any reason, the firm is unable to reach this level of output, it will suffer a loss from this product. Any output in excess of break even generates profit for the company. The profits can be shown as the vertical distance between the TR and TC lines. As both are straight lines, the greater the level of output, the greater will be the profits. The maximum available profit occurs at the full capacity level of output.

It is unlikely, however, that the firm will be producing at full capacity. There will be a variety of reasons for output being less than full capacity output (such as shortages of resources or inadequate demand). The horizontal distance between the break-even level of output and the current level of output is known as the **margin of safety**. Where break-even output is a high percentage of actual output, the margin of safety and, therefore, the scope for profit is small.

We can see from Figure 33.2 that a rise in price will lower the break-even level of output. Similarly, a reduction in fixed or variable costs per unit will have the same impact.

### Calculating break-even output

It is possible to calculate break-even output without the use of graphs. This involves the concept of **contribution**, which can be defined as the excess of price over variable costs. Any money received over the variable costs makes a contribution towards the fixed costs. If we know the contribution per unit, we can easily calculate the number of ‘contributions per unit’ we require to fully cover the fixed costs. This can be shown in the following example.

#### Exercise

Assume:

(i) fixed costs are £500,000;
(ii) the variable cost per unit amounts to £1;
(iii) the selling price is £5 per unit;
(iv) planned output is 200,000 units per year.

Calculate the:

(a) break-even output;
(b) margin of safety;
(c) profits at planned output.

#### Answer

(a) To calculate break-even output, divide fixed costs by the contribution per unit. Each unit is sold for £5 but variable costs amount to £1 per unit. Consequently, each
unit sold contributes £4 to fixed costs, which are £500,000. Break-even occurs at £500,000 = 125,000 units
\[ \frac{\text{£4}}{\text{£5}} = 125,000 \text{ units} \]

(b) The margin of safety is current output minus break-even output. In this example, it is 200,000 minus 125,000, which equals 75,000 units.
Break even occurs at 62.5 per cent of planned output. The margin of safety is 37.5 per cent of planned output.

(c) It is possible to calculate profits in a variety of ways, but break-even analysis provides us with a distinctive and simple technique. We know that each unit of output makes a £4 contribution after deducting variable costs. Up to break-even output, the contribution was towards fixed costs; beyond break even, the contribution is towards profits. In this example, profits will be £4 multiplied by the margin of safety of 75,000 units. Hence, profits amount to £300,000.

**Break even in terms of sales revenue**

The basic technique can be modified to calculate the level of sales revenue required to break even.

Suppose a product involving variable costs of £2 was sold for £6. Fixed costs amounted to £200,000. The formula for break even in revenue terms is:

\[ \frac{\text{Fixed costs}}{\text{Contribution per unit}} \times \text{Price per unit} \]

In the example, break even occurs when sales revenue is:

\[ \frac{\text{£200,000}}{\text{£4}} \times \text{£6} = \text{£300,000} \]

**A target rate of profit**

With another slight modification of the basic formula, we can calculate the level of output (or, separately, the level of price) necessary to achieve a certain level of profit.

If we assume that fixed costs amount to £1 million, variable costs come to £5 per unit and the selling price is £10 per unit, we can calculate that break even occurs when \( \frac{\text{£1m}}{\text{£5}} \) are sold – that is 200,000 units. However, the firm does not want to merely break even but seeks a target profit of £200,000. To achieve its target, it must produce and sell a further £200,000, or 40,000 units above the break even level.

We can calculate the level of output needed to achieve the profit target by using the following formula:

\[ \frac{\text{Fixed costs plus target profit}}{\text{Contribution per unit}} \]

\[ = \frac{\text{£1m + £200,000}}{\text{£5}} = \text{240,000} \]

A variation on this concerns what price a business would have to charge to achieve a target profit at a given level of output. Let us use data from the previous example.

Fixed costs: £1 million
Variable costs: £5 per unit
Chosen level of output: 240,000
The target profit is now £300,000.
What price should the organization charge?

The firm requires a total contribution of £1 million plus £300,000 from 240,000 units of output. This comes to £5.42 per unit. It would have to charge a price of £5 + £5.42 = £10.42 to achieve the profit target from its chosen level of output.

The use of break-even analysis to achieve a profit target can be shown graphically, as in Figure 33.3. To achieve the profit target it is necessary to produce the total revenue equal to total costs plus the target profit. This requires an increase in price to raise the TR line to TR.

**Criticisms of break-even analysis**

Break-even charts may provide a useful way of looking at cost, output and revenue relationships. However, they suffer from a number of limitations:

- Fixed costs are likely to change at different
levels of activity. Perhaps it would be more accurate to represent fixed costs as a stepped line. Neither variable costs nor sales revenue are likely to be linear. Discounts, overtime payments and special delivery charges all contribute to non-linearity. Economists would depict the break-even chart as shown in Figure 33.4.

Accountants would defend the use of linear TC and TR curves by arguing that, over the range of output depicted in the data (this is known as the relevant range), the relationship between volume and both costs and revenue is a linear one. Over the relevant range, certain costs are fixed and the variable costs per unit are constant. Only if the firm goes outside the relevant range will both fixed costs and variable costs per unit change. Similarly, over the relevant range, price per unit is constant, thus giving a straight line TR curve. Again, if the firm moves outside the range, it will have to adjust the price, thus destroying the linearity of the TC curve. This concept of the linearity of the curves being confined to the relevant range means that the difference between the economists' and the accountants' perceptions of break even is not as fundamental as might be assumed.

**Conclusion**

In this chapter we have investigated break-even analysis as a method of decision making in business. It can be used to discover whether or not profits can be made at the planned level of output. It can also be used in decision making regarding the price to be charged and/or quantity to be sold to achieve a target level of profits. As with other aspects of quantitative analysis, a true understanding of the techniques comes with frequent practice. You are, therefore, advised to work through the exercises at the end of the chapter.

**Key formulae**

**Break-even point**
- (in units)
  \[ \text{Break-even point (in units)} = \frac{\text{Fixed costs}}{\text{Contribution per unit}} \]

**Break-even point**
- (in sales revenue)
  \[ \text{Break-even point (in sales revenue)} = \frac{\text{Fixed costs}}{\text{Contribution per unit}} \times \text{Price per unit} \]
Margin of safety = Current output minus break-even output.

Profit = Margin of safety × contribution per unit

Level of sales required to achieve target profit (in units) = \( \frac{\text{Fixed costs} + \text{target profit}}{\text{Contribution per unit}} \)

Key concepts

Break-even output The level of output at which costs are fully covered by sales revenue.

Contribution per unit Price minus variable costs.

Fixed costs Costs that do not rise as output rises.

Margin of safety Current output minus break-even output.

Variable costs Costs that rise in proportion to output.

Essay questions

1 Evaluate break-even analysis for business decision making.

2 Analyse the complications for break-even analysis that result from each of the following features of life for real business:
   (a) the non-standard product;
   (b) the multi-product firm;
   (c) the stepped rise in fixed costs;
   (d) the non-linear cost and revenue curves.

3 Using sketch graphs, analyse the consequences for the break-even point of each of the following:
   (a) a rise in fixed costs;
   (b) a rise in variable costs per unit;
   (c) a price reduction;
   (d) fixed costs being a high percentage of total costs.

4 The margin of safety for a product produced by a firm is currently 5 per cent.
   (a) Explain what this means and what are its implications.
   (b) Evaluate strategies to improve the situation.

5 The standard linear break-even chart suggests that profits will always be increased by raising the level of output. Analyse why this is not true in the real world.

Exercises

1 The variable cost of the electric kettle manufactured by Fair Oak Domestic Appliances Ltd is £4. The company, which sells its kettles direct to retailers for £10, expects its net profit for the year just ending to be £270,000 after allowing for fixed costs of £90,000. The productive capacity of the company is underutilized and the marketing manager suggests that a 10 per cent reduction in selling price will bring about a 25 per cent increase in sales.

   (a) Define the term 'contribution'. What is the contribution per unit in the above case?
   (b) What level of sales is necessary to break even?
   (c) If profits are £270,000 after allowing for fixed costs of £90,000, what is the current volume of output and sales?
   (d) Calculate the:
      (i) sales revenue at this volume of sales;
      (ii) sales revenue resulting from the implementation of the marketing manager's proposal.