Break-Even & CVP Analysis

One of the main concerns in running a business is achieving a desired level of profitability. Cost-volume profit analysis and break-even analysis are used to evaluate the potential effects of decisions on profitability.

You would know if you sold 5 shirts and each shirt cost $10, that you had received $50 worth of sales revenue. Total Revenue (TR) is found by multiplying the quantity (Q) of units sold by the selling price per unit (P). We write the equation as shown below:

$$TR = P \times Q$$

If as a business you pay $200 a month in rent, and you sold 5 shirts that cost you $8 each to produce in one month, your total costs for the month would be $200 + ($8/unit × 5 units) = $240. Total Cost (TC) is made up of fixed costs and variable costs. **Fixed costs** (FC) are things like rent or utilities bills: these costs remain constant for all levels of production. **Variable costs** are things like material costs: they increase or decrease with the number of units produced. We find the total variable costs by multiplying the variable cost per unit (VC) times quantity (Q).

$$TC = FC + VC \times Q$$

You can use a **break-even analysis** to find the break-even point in terms of quantity of items or in dollars. Think about the everyday use of "just breaking even" — the money you make just covers your expenses: your total revenue from sales just covers your total costs (no profit and no loss). In other words, your revenue equals your costs.

$$TR = TC$$
$$P \times Q = FC + VC \times Q$$

Example: A market survey for a new gizmo indicates that the product can be sold at $40 per unit. The fixed costs per period are $8430, and the variable selling expense is $25 per unit. Production capacity per period is 850 units. Perform a break-even analysis and find: (i) the equations for total revenue and total cost, (ii) the break-even point in units and (iii) the break-even point in dollars.

Solution:

(i) Total Revenue = Price × Quantity   Price is $40 per unit, so:
     TR = 40 × Q   (this tells us how to find TR at any quantity)

     Total Cost = FC + VC × Q
     Fixed costs are given at $8430 and the variable cost per unit is $25, so:
     TC = 8430 + 25 × Q   (this tells us how to find TC at any quantity)

(ii) At the break-even point, TR = TC, so we set the two equations equal to each other and solve for Q:

40 × Q = 8430 + 25 × Q

15Q = 8430

Q = 562 units

(iii) Now that we know the number of units at the break-even point, we can substitute into EITHER the TR or TC equation and find the break-even point in dollars:

TR = 40 × 562 = $22,480

TC = 8430 + 25 × 562 = $22,480

In some cases you may be given a question in total sales dollars rather than unit prices. In this case we assume that our output is sold in $1 increments and proceed. Total revenue (or sales) will be given as $1 × Q, or simply Q. Fixed costs will remain the same. Variable costs are directly related to sales volume (both depend on quantity), so if we take Total Variable Costs ÷ Total Sales, this will give us the fraction of every dollar of sales that goes to variable costs or the variable cost per unit.

Example: The following information is found in the accounting records of Acme Co. Fixed costs per period are $7200. Sales volume for the last period was $29,040 and variable costs were $17,424. Capacity per period is a sales volume of $35,000. Find the break-even point in dollars and as percent-capacity.

Solution:

Total Revenue = Q

Total Cost = FC + (TVC/Sales) × Q ← | TVC/Sales is called the Per Dollar Variable Cost or Per Dollar Variable Factor.

TC = 7200 + (17424/29040) × Q

TC = 7200 + 0.60 × Q

Variable costs are 60% of sales dollars)

The break-even point is found by setting Total Revenue = Total Cost

Q = 7200 + 0.60Q

0.40Q = 7200

Q = 18000

In dollars the break-even point is $18,000.00.

When you have to find the break-even point as a percent of capacity, the capacity (whether in dollars or quantity) is given in the question. Choose the break-even point in units that match the capacity units and divide.

$$\text{BE \% capacity} = \frac{\text{BE (in quantity or dollars)}}{\text{Capacity (in quantity or dollars)}} \times 100$$

The breakeven point as a percent capacity is $18000/$35000 = 0.514 =51.4%

Contribution margin and contribution rate

The **contribution margin** is the difference between the selling price and the variable cost (whether they are given as per unit prices or total dollars). But what does the contribution margin mean? It's how much money is left over after variable costs are paid to CONTRIBUTE toward fixed costs and profit.

$$CM = P - VC$$

For a problem with unit prices given, find the contribution margin per unit.
In the case where the problem gives you total sales dollars and total variable cost, the contribution margin is given as:

$$CM = 1 - (TVC)/Sales$$

Note this equation tells you what fraction of every dollar contributes towards fixed costs and profit.

The **contribution rate** is the contribution margin expressed as a percentage of selling price. For problems with per unit prices given,

$$CR = CM/P \times 100\%$$

For problems with total sales dollars, the contribution rate is: $CR = CM \times 100$ (because the CM is already expressed as a fraction of the sales).

Example: A games dealer has the following data in her operating budget. Sales were $1,020,000 with fixed costs for the period of $160,000. The total variable cost was $581,400. Find the contribution margin, contribution rate, and break-even point in sales dollars.

Solution:

This is a total sales dollar problem, so recalling that price per unit is assumed to be $1, and that variable costs are expressed as (TVC/Sales),

$$CM = 1 - (TVC/Sales)$$
$$CM = 1 - (581,400/1,020,000) = 0.43$$

The contribution rate is the contribution margin as a percentage of selling price:
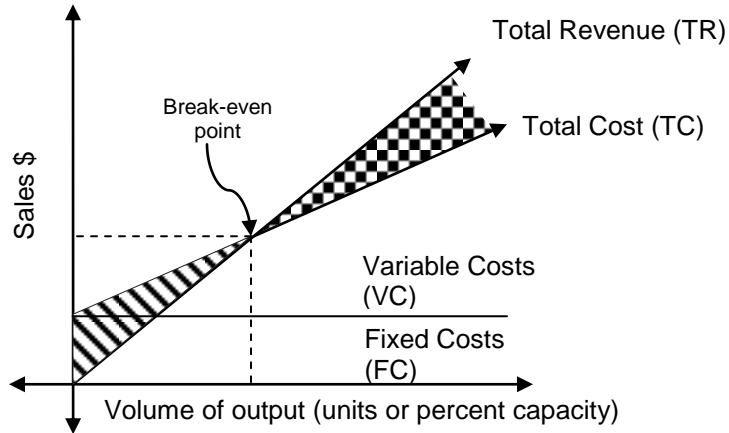
$$CR = 0.43 \times 100 = 43\%$$

The break-even sales dollars is:

$$BE = FC/CM = \$160,000/0.43 = \$372,093.02$$

Using Graphs for Break-Even Analysis

The relationship between quantity and revenue and quantity and costs can be represented graphically by plotting the equations discussed above. The intersection of the two lines (total costs and total revenue) represents the break-even point. The horizontal axis shows volume of output (Q) and the vertical axis shows sales in $. The checkered area shows where profit is obtained; the striped area shows loss is incurred (as total cost is greater than total revenue).

Analysis of Changes to Cost-Volume-Profit Relationship

If fixed costs or variable costs or selling price of an item changes, this will obviously affect the relationship between TR and TC. For instance, in the break-even analysis (TR = TC) if the fixed costs increase, the number of products sold to break even must also increase. If the selling price of an item decreases, the break-even quantity will also decrease.

To determine a profit or loss other than 0, we re-arrange the equation to:
TR − TC = profit (loss)
We can continue to analyze how changes in the selling price, fixed costs or variable costs will affect the profit (loss) for the business.

Practice Problems

1. The Astronomical Telescope shop plans to introduce a new model based on the following information: Rent and utilities per period are $4144; variable cost per unit is $176; selling price per unit is $213; and capacity per period is 180 units.
   (a) Determine the (i) contribution margin; (ii) contribution rate.
   (b) Compute the break-even point (i) in units; (ii) in dollars and (ii) as a percent of capacity.
   (c) Draw a detailed break-even chart.
   (d) For each of the following independent situations, determine the break-even point in units if (i) rent and utilities are increased to $5069; (ii) variable costs are reduced to $157.
   (e) For each of the following independent situations, determine (i) how many units must be sold to make a profit of $2000; (ii) the new selling price if selling 110 units yields a profit of $2500.

2. The operating budget of the HoneyBee company is given below.

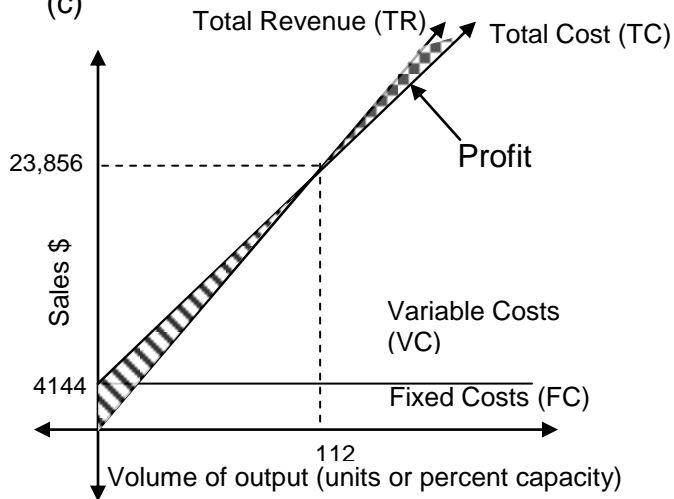 | | | |
   |---|---|---|
   | Sales | | $425000 |
   | Fixed costs | $122000 | |
   | Variable costs | $255000 | |
   | Total costs | | $377000 |
   | Net Income | | $53000 |

   Sales dollars at capacity: $531,250.
   (a) Determine the (i) contribution margin; (ii) contribution rate
   (b) Calculate the break-even point (i) in dollars; (ii) as a percent of capacity
   (c) Determine the break-even point in dollars if the fixed costs are reduced by $12,100 while variables costs are changed to 68% of sales.

3. Speedy's graphic design store plans to sell 62 jobs next week, at an average cost of $325 each. Their weekly expenses are $5270.00
   a. How much must they charge for each job to break even?
   b. If they want to make a profit of $1240, what price do they have to charge?
   c. If they sell 75 jobs during a week, how much profit will they realize? (using the price from part b)
   d. If they sell 100 jobs through a special promotion what is the minimum price they could charge to break even?

Solutions

1. (a) (i) $37.00 (ii) 17.37%
   (b) (i) 112 units (ii) $23,856 (iii) 62.22%
   (c)

Total Revenue (TR) — Total Cost (TC) — Profit — 23,856 — Sales $ — Variable Costs (VC) — 4144 — Fixed Costs (FC) — 112 — Volume of output (units or percent capacity)

   (d) (i) 137 units
       (ii) 74 units
   (e) (i) 167 units (166.05 units, round up)
       (ii) $236.40

2. (a) (i) 0.40   (ii) 40.00%
   (b) (i) $305,000 (ii) 57.41%
   (c) $343,437.50

3. (a) $410
   (b) $430
   (c) $2605
   (d) $377.70