MBA in Food & Agribusiness

Financial Management

Cost – Volume – Profit Analysis

Learning outcomes:

- Explain how the accountant's view of cost behavior differs from that of the economist.
- Define and calculate contribution and breakeven point.
- Use breakeven analysis to explore the effect of changing unit selling, unit variable cost, fixed cost and output levels.
- Show how CVP analysis can be used in short-term decision making.
- Explain the limitations of cost-volume-profit analysis.

Fixed and variable costs

- A *variable cost* is one, which varies directly with changes in the level of activity, over a defined period of time.

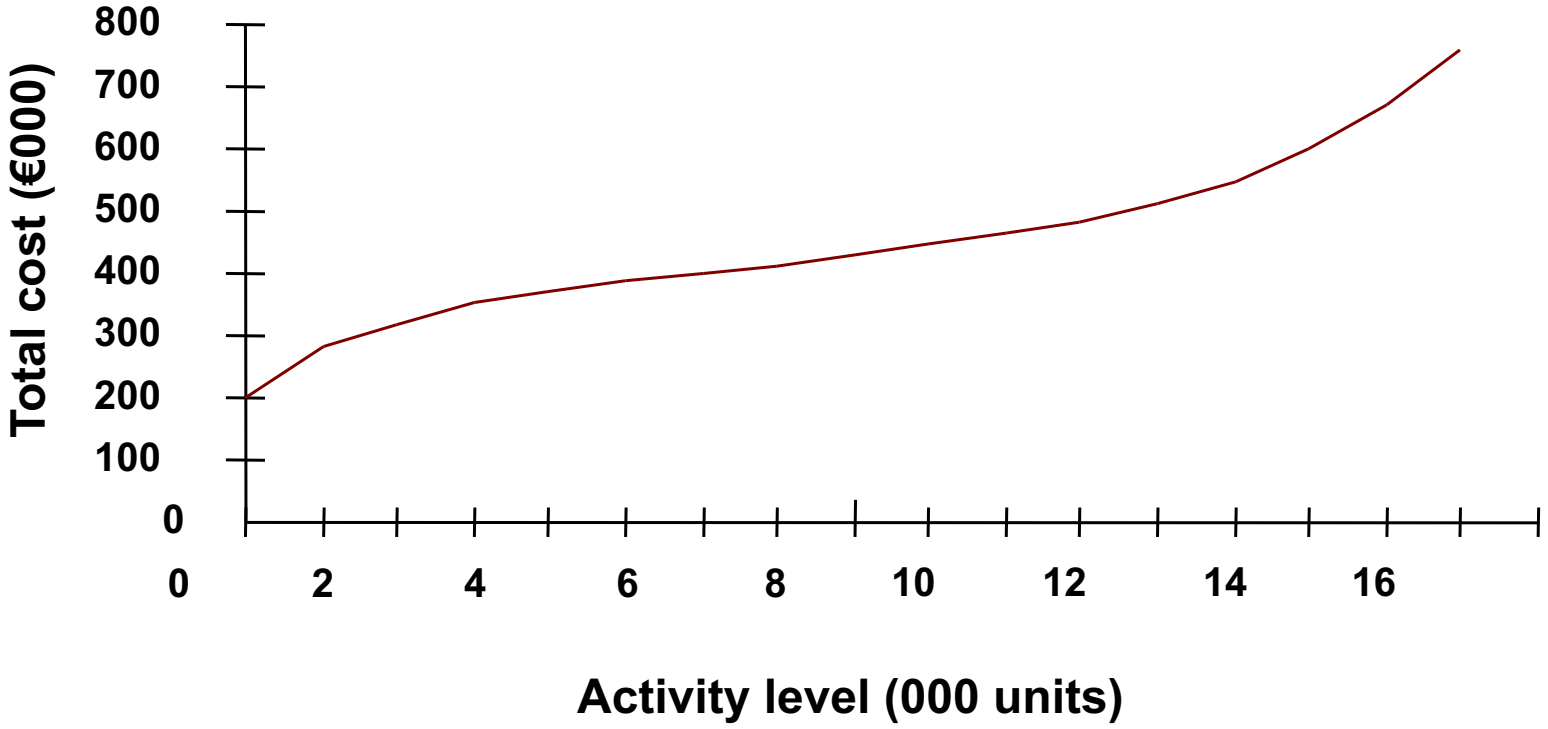
- A *fixed cost* is one, which is not affected by changes in the level of activity, over a defined period of time.

Cost related to activity level

- Economist’s view
- Accountant’s view

The economist's view

Total cost varying with activity



The economist's view (cont)

Revenue and costs

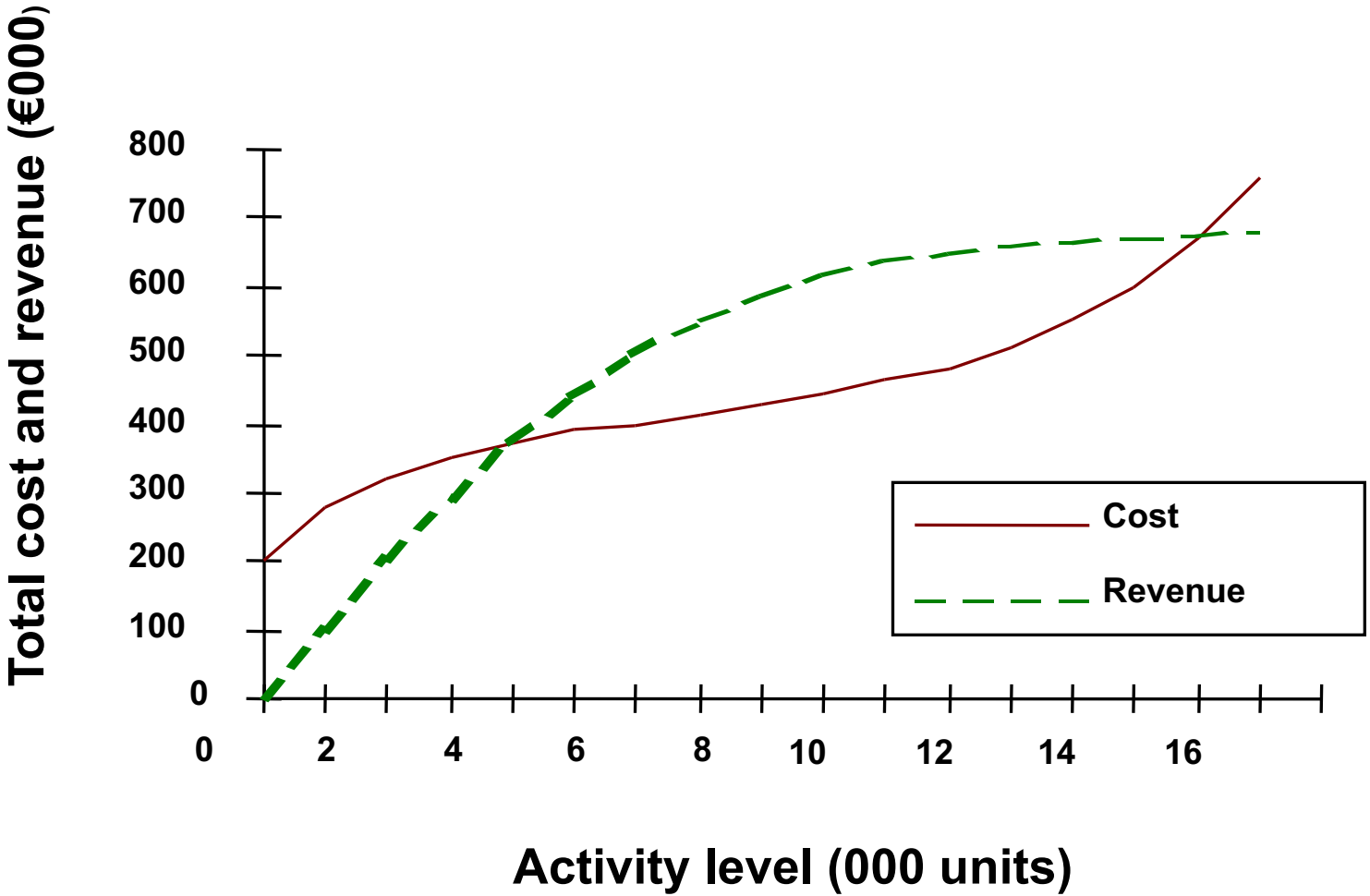
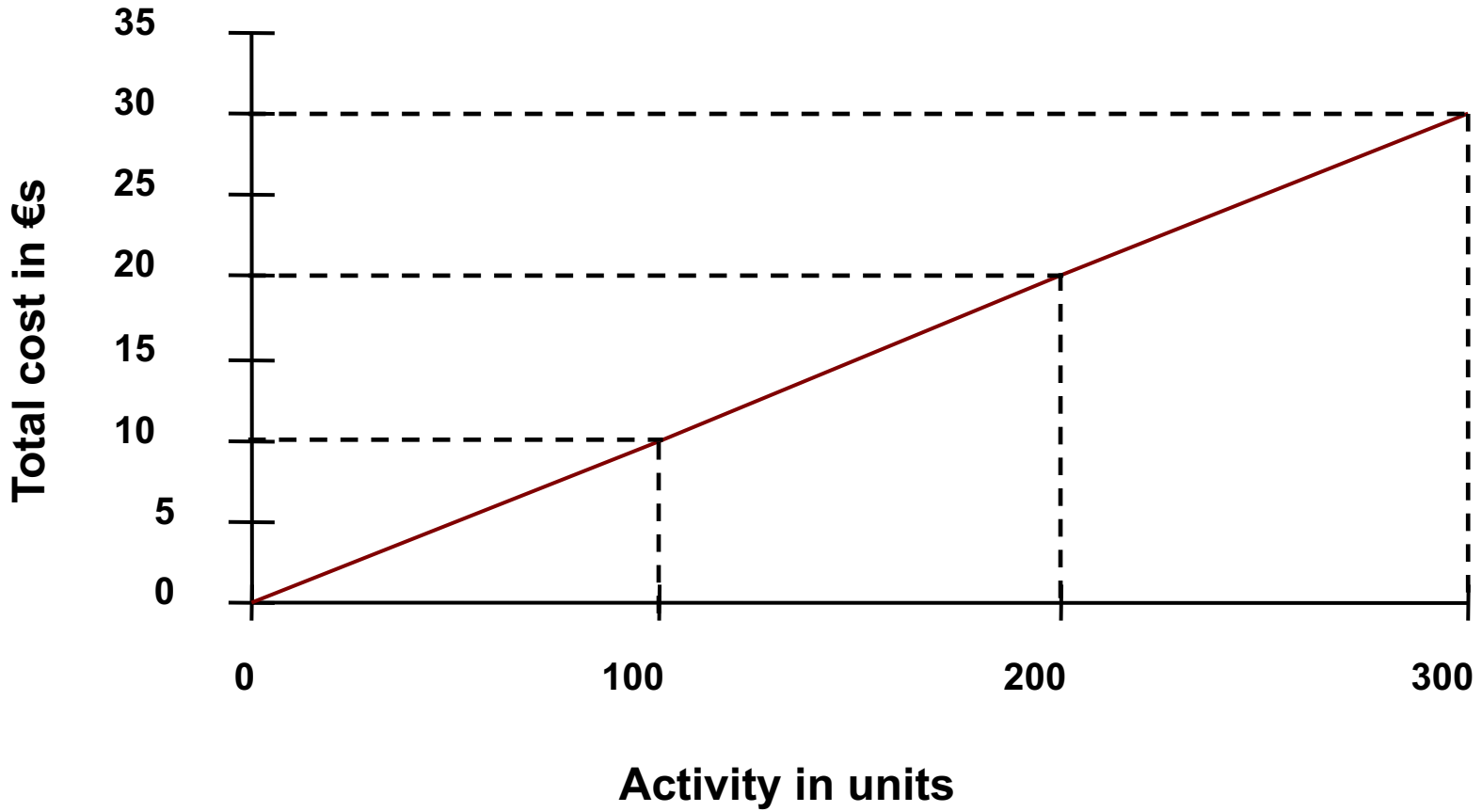


Table of data showing variable and fixed costs

Activity level	*0 units*	*100 units*	*200 units*	*300 units*
	€	€	€	€
Variable cost	0	10	20	30
Fixed cost	20	20	20	20
Total cost	20	30	40	50

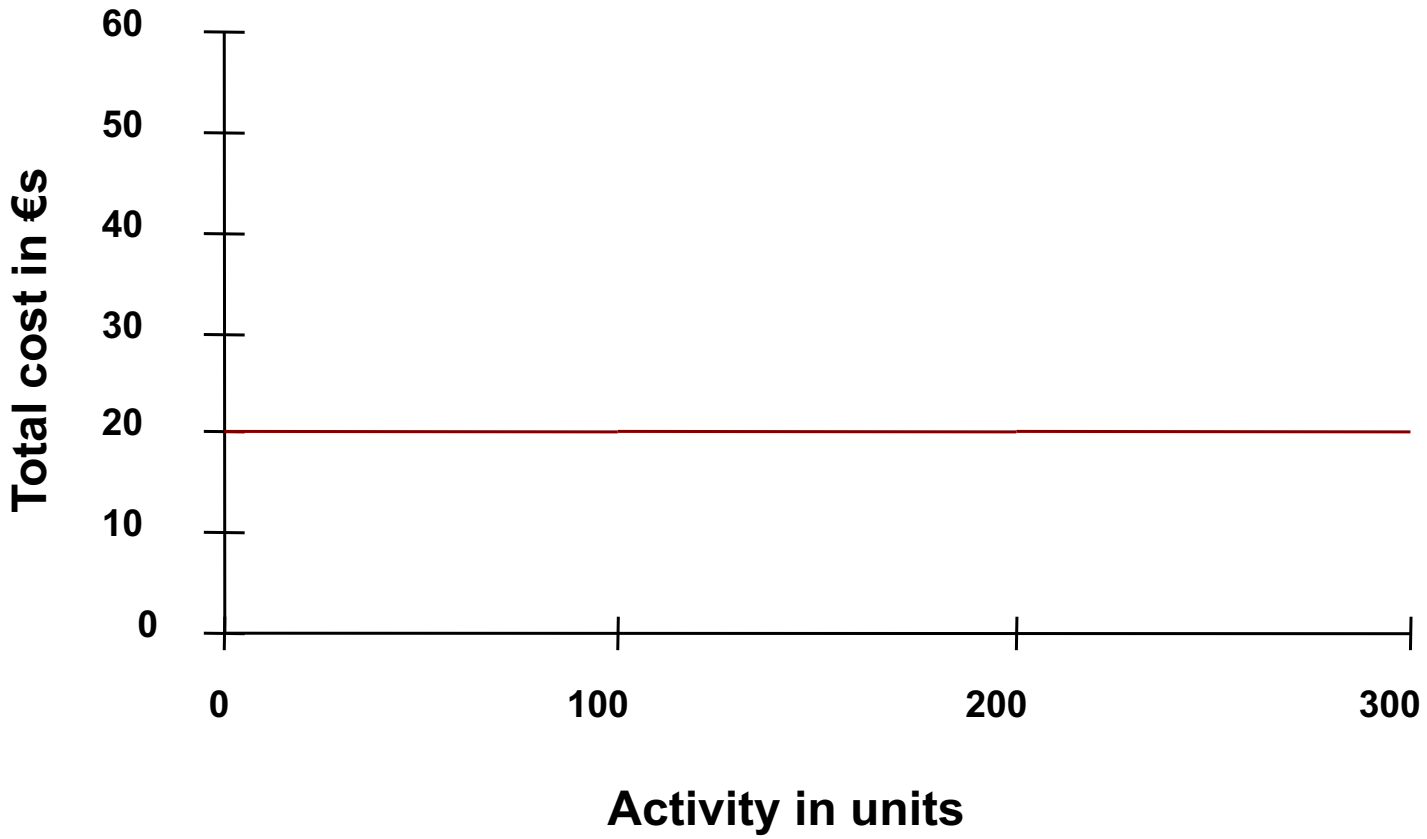
The accountant's view

Variable cost

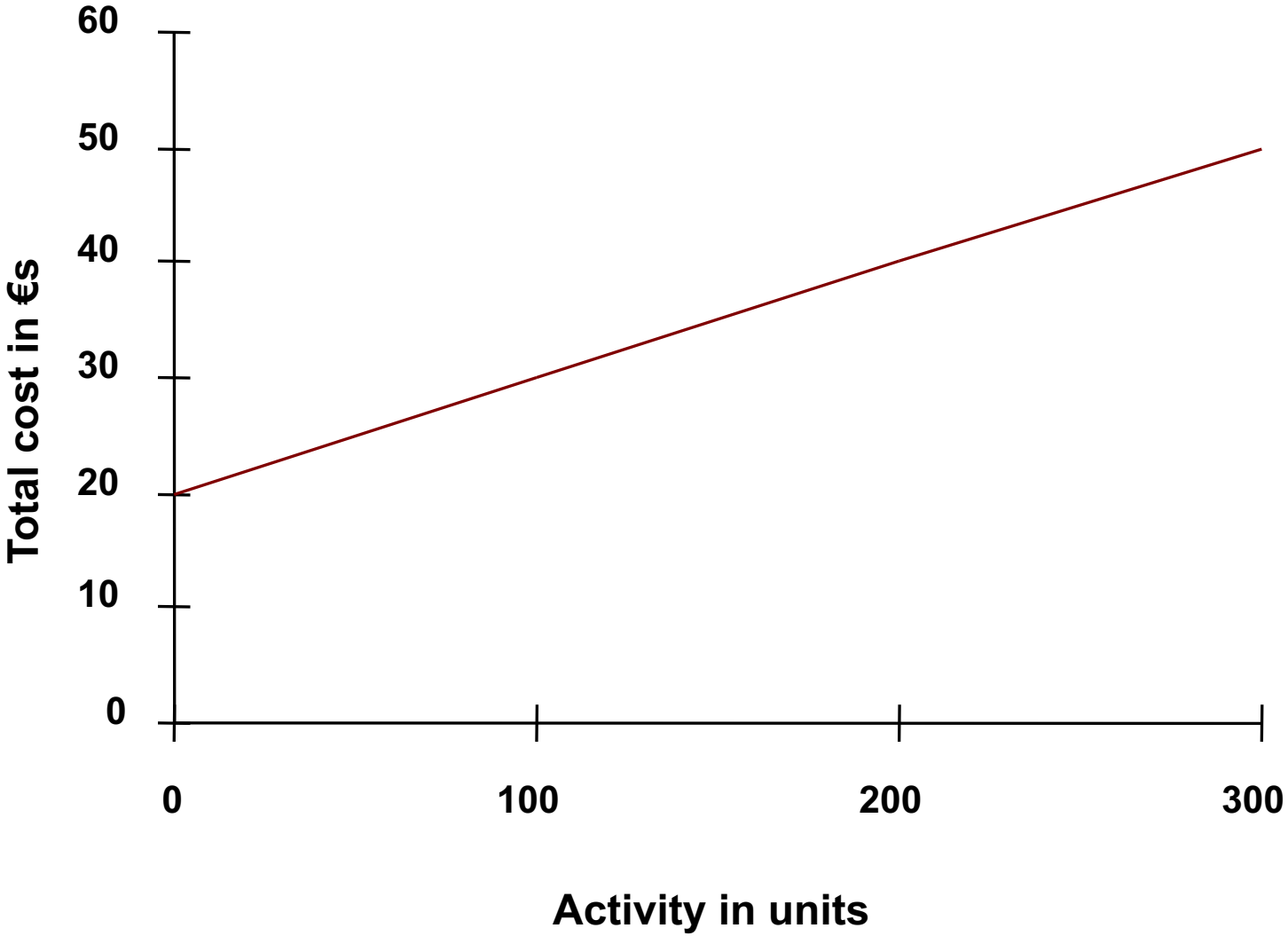


The accountant's view (cont)

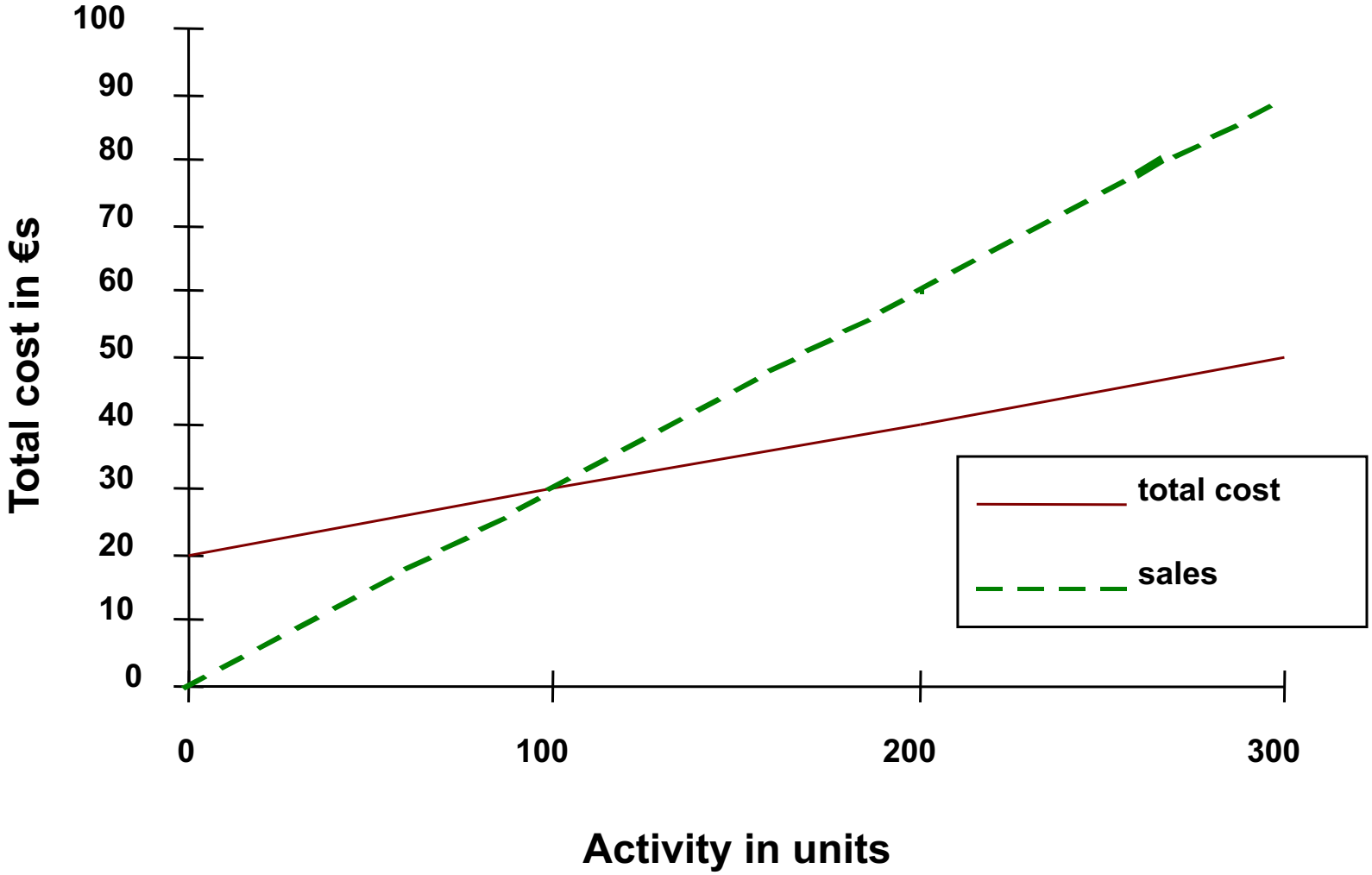
Fixed cost



Total cost


60
50
40
30
20
10
0
Total cost in €s
0
100
200
300
Activity in units

Total cost and total sales

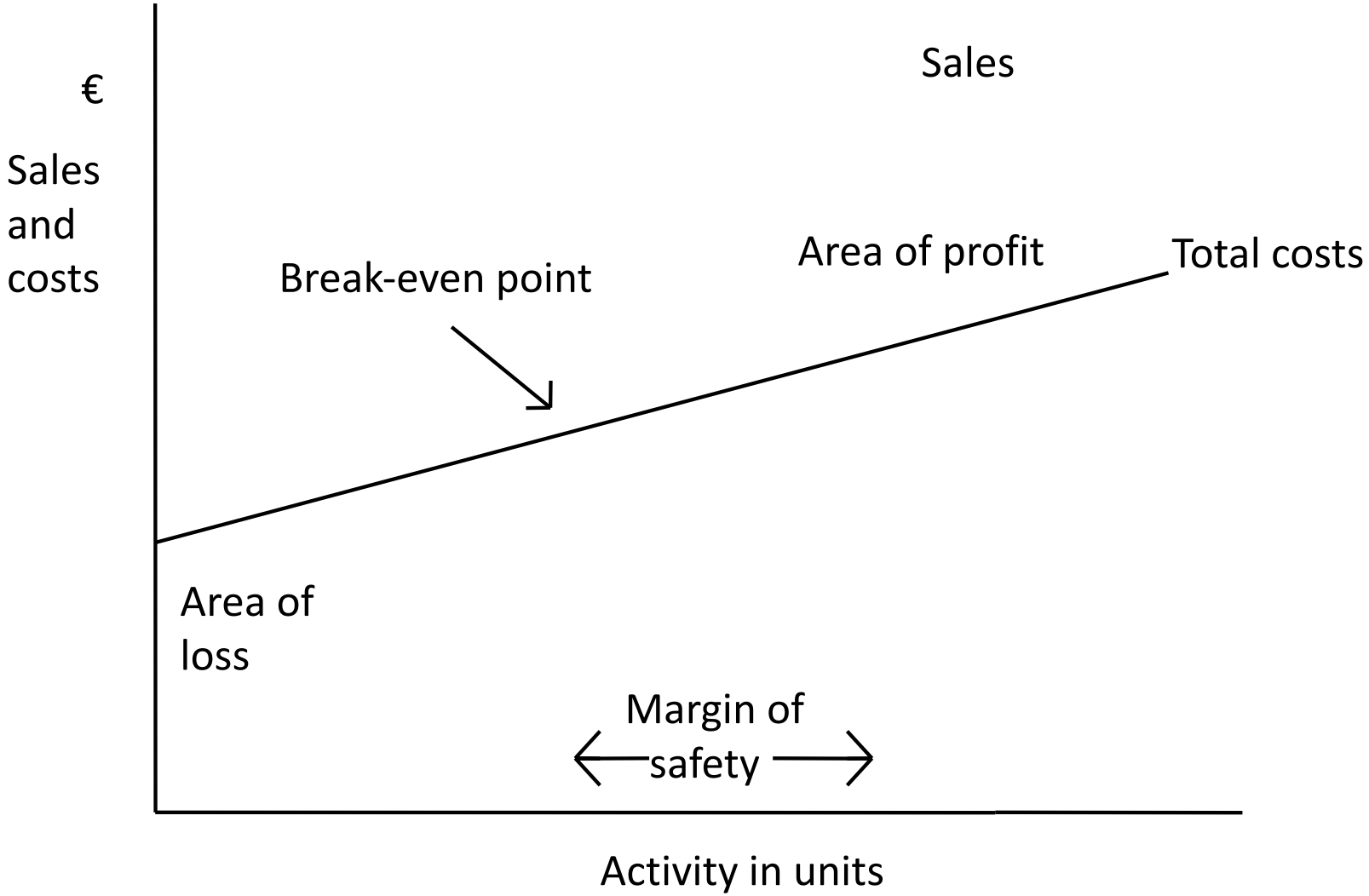


Definitions

- The *break-even point* is that point of activity (measured as sales volume) where total revenues and total costs are equal,
  - so that there is neither profit nor loss.

- The *margin of safety* is the difference between the break-even sales and the normal level of sales (measured in units or in €s of sales).

Break-even chart



Equations

CVP Analysis

A technique that examines changes in profits in response to changes in sales volume, costs and prices.

- Break-even point

  Total Revenues = Total Costs

  Total Revenues - Total Costs = Zero Profit

  (sales)

- Contribution Margin (CM)

  Sales Price - Variable Cost = CM per unit

  Sales - Total Variable Costs = CM in total

  CM ratio = $\frac{\text{CM in total}}{\text{Sales}}$

Cost-Volume-Profit analysis (example 1)

Break-even point $Q^* = \frac{\text{Total fixed costs}}{p - vc}$ (in units)

Contribution margin per unit

Break-even point $V^* = \frac{\text{Total fixed costs}}{1 - vc / p}$ (in euros)

Contribution margin ratio

$\frac{100{,}000}{12 - 4} = 12{,}500$ units

If fixed costs are 100,000 €, unit sales price is 12 €, and unit variable cost is 4 €, the break-even point is 12,500 units

$\frac{100{,}000}{1 - \frac{4}{12}} = 150{,}000$ €

If fixed costs are 100,000 €, unit sales price is 12 €, and unit variable cost is 4 €, the break-even point is 150,000 €

Profit and Loss Account proof

	Sales	**150,000 € (12,500 * 12)**
Less	**Total variable costs**	**(50,000) (12,500 * 4)**
	Contribution Margin	**100,000 €**
Less	**Total fixed costs**	**(100,000)**
	Profit before taxes	**-0-**

If fixed costs are 100,000 €, unit sales price is 12 €, and unit variable cost is 4 €, the break-even point is 12,500 units

Using Cost-Volume-Profit Analysis

Margin of safety

$$\text{Percentage margin of safety} = \frac{\text{Expected sales - Break-even sales}}{\text{Expected sales}}$$

$$\textbf{Margin of safety} = \frac{Q - Q^*}{Q} = 1 - \frac{Q^*}{Q}$$

$$\textbf{Margin of safety} = \frac{V - V^*}{V} = 1 - \frac{V^*}{V}$$

- Budgeted (or actual) sales after the break-even point
- Indication of risk

If expected sales are 15,000 units, the margin of safety is:

$$\frac{15{,}000 - 12{,}500}{15{,}000} = 0.1667 \quad (16.67\%)$$

16.67% is our margin of safety
(sales can drop 16.67% that we still have profit)

Example 2: Market trader

- A market trader rents a stall at a fixed price of €200 for a day and sells souvenirs.

- These cost the trader 50 cents each to buy and have a selling price of 90 cents each.

- How many souvenirs must be sold to break even?

Calculation of contribution

- *Contribution per unit* is the sales price per unit minus the variable cost per unit.

- It measures the contribution made by each item of output to the fixed costs and profit of the organisation.

Calculation of contribution (cont)

$$\text{Break-even point} = \frac{\text{Fixed cost}}{\text{Contribution per unit}}$$

- Contribution is 40 cents per souvenir
  - Selling price 90 cents *minus* variable cost 50 cents
- Fixed costs are €200.

Break-even point = $\frac{200}{0.40} = \frac{500 \text{ units}}{} \times €0.9 = \frac{€450}{}$

- **Level of Activity** = $\frac{\text{FC + TOI}}{\text{Contribution per Unit}}$.

Algebraic method

- The equation for the break-even point is:

Sales = Fixed costs + Variable costs

- If the number of souvenirs sold at the break-even point is *n*, then the total sales revenue is 0.9*n* and the total variable cost is 0.5*n*

  $0.9n = 200 + 0.5n$

  $0.4n = 200$

- Solving the equation, n = 500 souvenirs to be sold to break even.

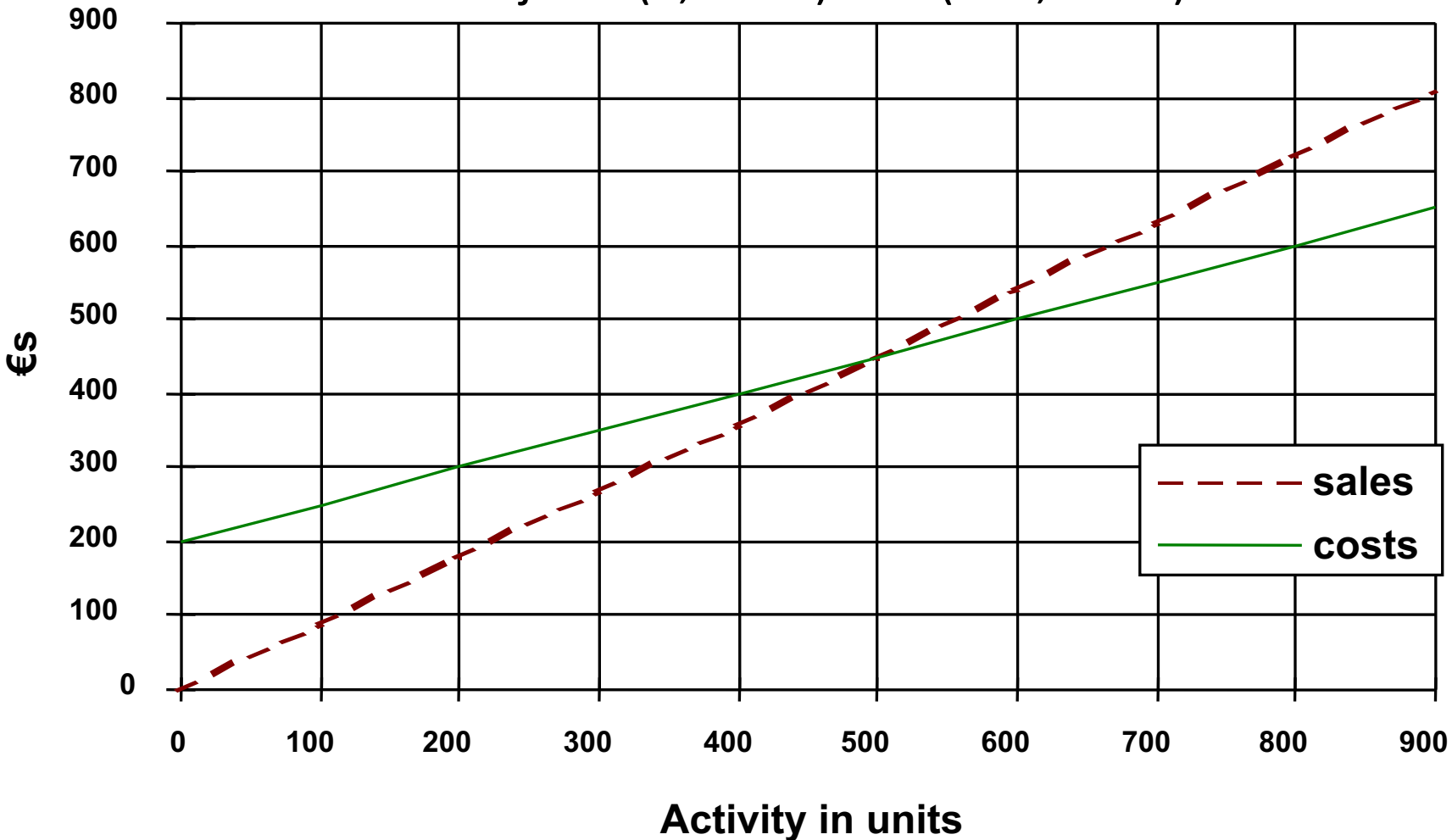
Breakeven chart

- Sales of 900 souvenirs, 90 cents each = €810
- The sales line will therefore join the points (0,€0) and (900, €810) on the graph.
- Variable cost of 900 souvenirs at 50 cents each = €450
- Fixed cost = €200
- Total cost €650
- Profit €810 - €650 = €160

Breakeven chart (cont)

The Revenue line is drawn at (0, €0) and (900, €810).

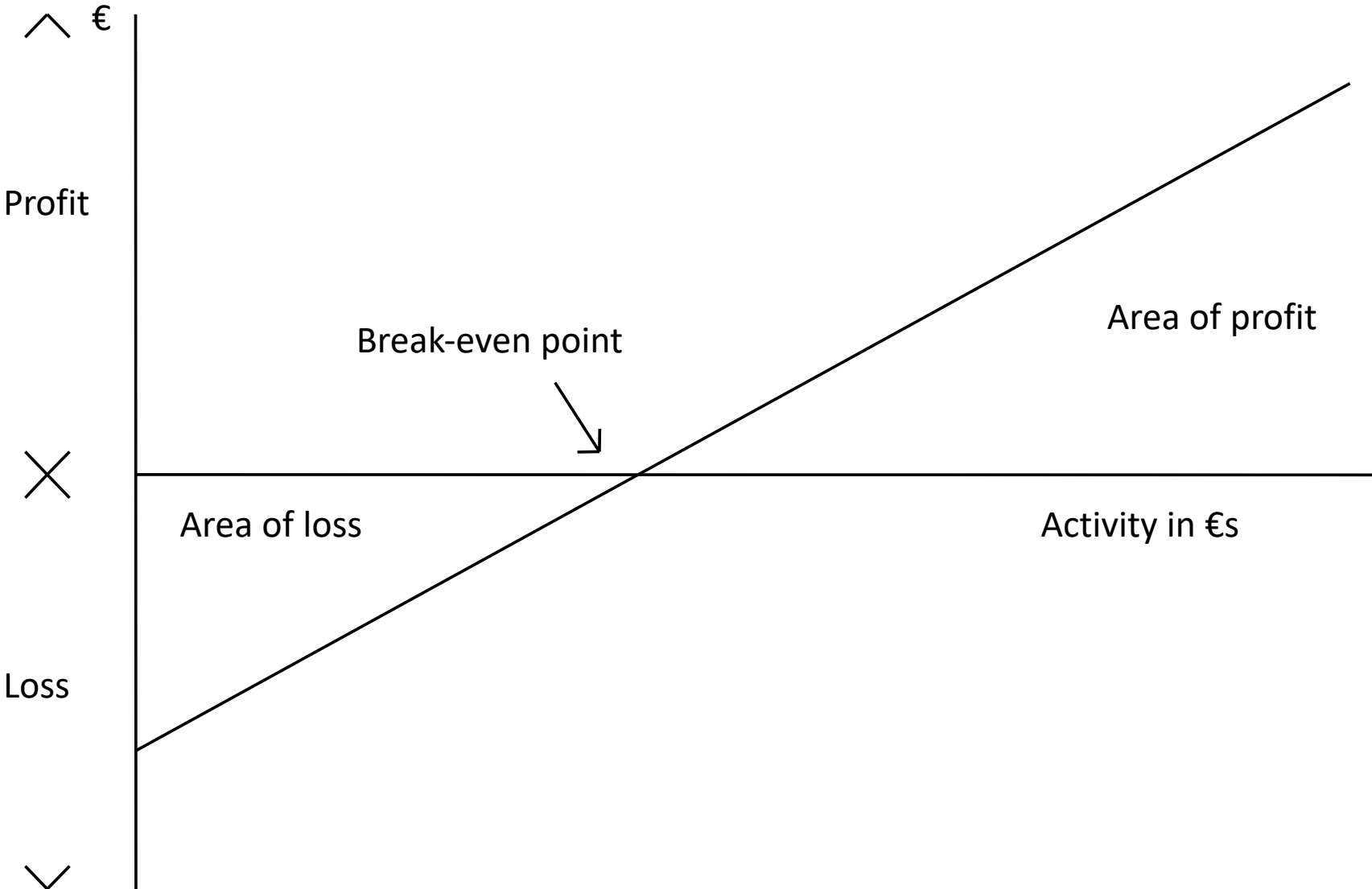
The total cost line joins (0, €200) and (900, €650).



Profit-volume graph

$$\textbf{Profit/volume ratio} = \frac{\text{contribution per unit}}{\text{selling price per unit}} \times 100\%$$

Profit-volume graph (cont)

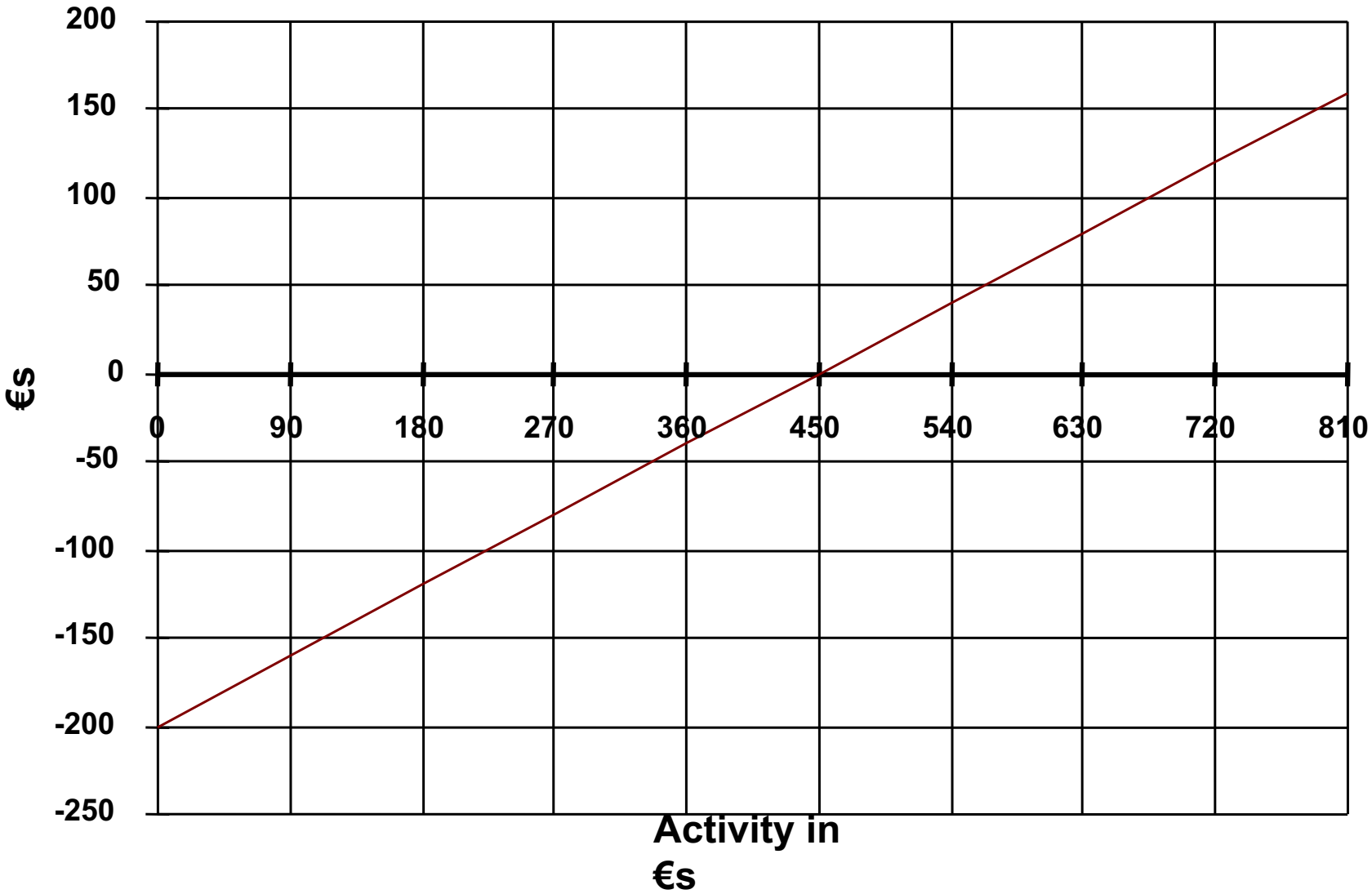


-Illustration

- When sales are zero, there will be a loss equal to the fixed cost, which gives the first point to plot at (€0,€–200).

- When 900 units are sold the sales are €810 and the profit is €160, giving the second point to plot at (€810, €160).

Profit-volume chart using data from the ‘market trader' case study



Profit-volume chart (cont)

- The break-even point of zero profit or loss is at a sales level of €450.
  - The graph rises by €40 of profit for every €90 increase in sales activity, giving a slope of 44.4%.
- The profit/volume ratio is calculated by formula as:

$$\frac{\text{contribution per unit}}{\text{sales price per unit}} = \frac{40 \text{ cents}}{90 \text{ cents}} = 44.4\%$$

Using break-even analysis

- What level of sales is necessary to cover fixed costs and make a specified profit?
- What is the effect of contribution per unit beyond the break-even point?
- What happens to the break-even point when the selling price changes?
- What happens to the break-even point when the variable cost per unit changes?
- What happens to the break-even point when the fixed costs change?

Covering fixed costs and making a profit

Data

Selling price per unit	80 cents
Variable cost per unit	30 cents
Fixed cost	€300
Desired level of profit	€400

Calculation

- The contribution per unit is 50 cents (80 cents – 30 cents).

- To find the break-even point, the fixed costs of €300 are divided by the contribution per unit
  - break-even point of 600 units.

Calculation (cont)

- To meet fixed costs of €300 and desired profit of €400 requires the contribution to cover €700 in all.

- Volume of sales required = $\frac{700}{0.5}$ = 1,400 units

- **Level of Activity** = $\frac{\text{FC + TOI}}{\text{Contribution per Unit}}$.

Calculating BEP – Level of Activity for TOI

Total Revenue – Total Costs = 0

Total Revenue = Total Costs

Total Revenue = Total Fixed Costs + Total Variable Costs

$$P \times Q_{BEP} = FC + V_u \times Q_{BEP}$$

$$P \times Q_{BEP} - V_u \times Q_{BEP} = FC$$

$$(P - V_u) \times Q_{BEP} = FC$$

$$Q_{BEP} = FC / (P - V_u)$$

If a targeted operated income (TOI) is desired then:

Total Revenue – Total Costs = TOI

$$Q_{BEP} = (FC + TOI) / (P - V_u)$$

Beyond the break-even point

- A dry-cleaning shop takes two types of clothing.
- Jackets cost €6 to clean and the customer is charged €9 per garment.
- Coats cost €10 to clean and the customer is charged €12 per garment.
- The monthly fixed costs are €600 for each garment (representing the rental costs of two different types of machine).
- The shop expects to take in 500 jackets and 500 coats in the month.

Calculation of BEP and of sales beyond the BEP

	Jackets	*Coats*
	€	*€*
Selling service price	9	12
Variable cost	6	10
Contribution per item	3	2
Fixed costs	€600	€600
Break-even point	200 units	300 units
Profit for sales of 500 units	€900 (300x €3)	€400 (200x €2)

Comment on calculation

- Both products have the same fixed costs

- However:
  - The jackets have a lower break-even point because they have a higher contribution per unit.
  - Beyond the break-even point they continue to contribute more per unit.
  - The profits at any given level of activity are therefore higher for jackets.

Change in selling price

- If the service selling price per unit increases and costs remain constant.

- Then the contribution per unit will increase and the break-even volume will be lower.

Change in selling price (cont)

- If the selling price of cleaning a coat rises to €15 then the contribution per unit will rise to €5.
  - That will require only 120 coats to break even.

- The effect of raising the price is that customers may move elsewhere
  - While it may not be difficult to exceed the break-even point at a selling price of €10 it may be extremely difficult at a selling price of €15.

Change in variable cost

- If the variable cost increases then the contribution per unit will decrease.

- With the result that more items will have to be sold in order to reach the break-even point.

Change in variable cost (cont)

- If it is possible to reduce variable costs then the contribution per unit will increase…

- The enterprise will reach the break-even point at a lower level of activity and will then be earning profits at a faster rate.

Change in fixed costs

- If fixed costs increase.

- Then more units have to be sold in order to reach the break-even point.

Change in fixed costs (cont)

- Where the fixed costs of an operation are relatively high, there is a perception of greater risk because a cut-back in activity for any reason is likely to risk leading to a loss.

- When an organisation has relatively low fixed costs, there may be less concern about the margin of safety because the break-even point is correspondingly lower.

Cost-Volume-Profit assumptions

- Costs can be accurately divided into their fixed and variable elements
- Company is operating within the relevant range

  (No change in capacity; Labor productivity, production technology, and market conditions remain constant)
- Total fixed costs remain constant
- Revenue and variable cost per unit are constant
- Singe product or constant sales mix
- Total contribution margin increases proportionally with increases in unit sales
- No change in inventory (production equals sales)

Applications of contribution analysis

- Accepting a special order to use up spare capacity
- Abandoning a line of business
- The existence of a limiting factor
- Carrying out an activity in-house rather than buy in a service under contract.
- Multiple-product break-even analysis

Special order to use up spare capacity

The special order is acceptable provided that:

- The sales price per item covers the variable costs per item,
- There is no alternative use for the spare capacity, which could give a higher contribution per item.
- May be way of breaking into other market

BUT

- Selling same product at different prices could lead to goodwill problems with the customers
- If problem of spare capacity is long term then better reduce capacity and fixed costs

Abandonment of a line of business

- In the short term it is worth continuing if the business makes a contribution to fixed costs.

- If the line of business is abandoned and nothing better takes its place, then that contribution is lost but the fixed costs run on regardless.

Abandonment of a line of business (cont)

Common for businesses to account separately for each department or section & to try to assess the relative effectiveness of each one

	Dep.1	**Dep.2**	**Dep.3**
Revenue	254	183	97
Costs	213	163	106
Profit / loss	41	20	(9)

	Dep.1	**Dep.2**	**Dep.3**
Revenue	254	183	97
Variable Costs	167	117	60
Contribution	87	66	37
Fixed Costs	46	46	46
Profit / Loss	41	20	(9)

Existence of a limiting factor

- Production is not only limited by the ability of business to sell

- Shortage of some production factor can also limit volume of output.

- Contribution analysis shows that maximisation of profit will occur if the activity is chosen, which gives the highest contribution per unit of limiting factor.

Existence of a limiting factor (cont)

Most profitable combination of products when the contribution per unit of the scarce factor is maximised

Product	A	B	C
Sales price	50	40	65
Variable cost	25	20	35
Contrib per unit	25	20	30
Labour time	5 hrs	3 hrs	6hrs
Cont per Ltd factor	5	6.67	5

In-house activity versus bought-in contract

• Production of any good or the provision of a service may be subcontracted.

• Must consider:
  - Costs involved
  - Loss of quality control
  - Potential unreliability of supply
  - Expertise and specialisation

•The decision should be based on:
  - Comparison of variable costs per unit, relating this to the difference in fixed costs between the options.

Multiple-product break-even analysis

- Assumes a constant product sales mix
- Contribution margin is weighted on the quantities of each product included in the “bag” of products
- Contribution margin of the product making up the largest proportion of the “bag” has the greatest impact on the average contribution margin of the product mix

Sales mix: relative proportions in which a company’s products are sold.

Multiple-product break-even analysis

Since different products will have different selling prices, different costs, and different contribution margins, the break-even point will depend on the mix in which the various products are sold:

$$\text{Break-even point } V^* = \frac{\text{Total fixed costs}}{\text{Average contribution margin ratio}}$$

Example: Wine bottles

	1 lt	½ lt.	Total
Units	20,000	10,000	
p	6 €	4 €	
vc	3.60 €	2 €	
Fixed costs			85,000 €

Multiple-product break-even analysis

Sales mix

20,000 x 6 = 120,000 € (75%)

10,000 x 4 = 40,000 € (25%)

	Lt.	½ Lt.
Selling price	6.00 €	4.00 €
Variable cost per unit	3.60 €	2.00 €
Contribution margin per unit	2.40 €	2.00 €
Contribution margin percentage (contribution margin per unit *over* selling price per unit)	40%	50%

Weighted-average contribution margin = 0.4 x 0.75 + 0.5 x 0.25 = 0.425

Break-even point = 85,000 / 0.425 = €200,000