



Break-Even and Short-term Decision Analysis

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The Breakeven Point

- **Cost-Volume-Profit** (CVP) and **Breakeven Point** (BP) analysis can be used to examine how various 'what-if' alternatives being considered by a decision maker affect operating profit.
- The **breakeven point** is frequently one point of interest in this analysis. Managers wish to avoid the stigma of making a loss.
- The **breakeven point** is that quantity of output where total revenues and total costs are equal, that is, where the operating profit is zero.
- Using the information in the following example, this section examines three methods for determining the breakeven joint:
 - The equation method,
 - The contribution margin method and
 - The graph method.



The Breakeven Point

- Mary Frost plans to sell Do-All Software, a software package, at a heavily attended two-day computer convention in Edinburgh. Mary can purchase this software from a computer software wholesaler at €120 per package with the privilege of returning all unsold units and receiving a full €120 rebate per package. The units (packages) will be sold at €200 each. Mary has already paid €2000 to Computer Conventions Ltd for the booth rental for the two-day convention.
- What quantity of units will she need to sell in order to break even? Assume there are no other costs.



The Breakeven Point: the Equation Method

- The first approach for computing the breakeven point is the equation method. Using the terminology in this chapter, the income statement can be expressed in equation form as follows:
 - Revenues – Variables costs – Fixed costs = Operating profit
 - $(USP \times Q) - (UVC \times Q) - FC = OP$
 - This equation provides the most general and easy-to-remember approach to any CVP situation. Setting operating profit equal to zero in the preceding equation, we obtain:
 - $€200Q - €120Q - €2000 = €0$
 - $€80Q = €2000$
 - $Q = €2000 \div €80 = 25$ units
- If Mary sells fewer than 25 units, she will have a loss; if she sells 25 units she will break even; and if she sells more than 25 units, she will make a profit. This breakeven point is expressed in units. It can also be expressed in sales euros: 25 units x € 200 selling price = €5000.



The Breakeven Point: the Contribution Margin Method

- A second approach is the contribution margin method, which is simply an algebraic manipulation of the equation method. Contribution margin is equal to revenues minus all costs of the output (a produce or service) that vary with respect to the units of output. This method uses the fact that:
 - $(USP \times Q) - (UVC \times Q) - FC = OP$
 - $(USP - UVC) \times Q = FC + OP$
 - $UCM \times Q = FC + OP$
 - $Q = \frac{FC + OP}{UCM}$
- At the breakeven point, operating profit is, by definition, zero. Setting $OP = 0$, we obtain:

$$\text{Breakeven number of units} = \frac{\text{Fixed costs}}{\text{Unit contribution margin}} = \frac{FC}{UCM}$$



The Breakeven Point: the Contribution Margin Method

- A contribution income statement groups line items by cost behavior pattern to highlight the contribution margin. The following such statement confirms the preceding breakeven calculations.

Revenues, €200 x 25	€ 5000
Variable costs, € 120 x 25	3000
Contribution margin, €80 x 25	2000
Fixed costs	2000
Operating profit	€0



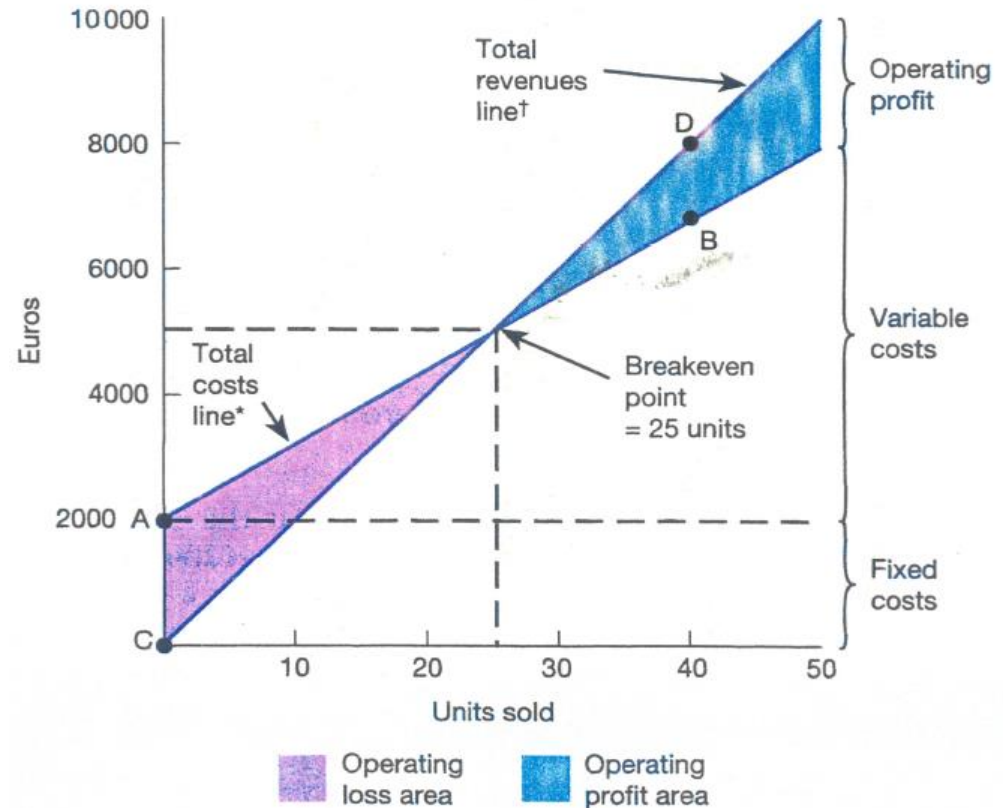
The Breakeven Point: the Graph Method

- In the graph method, we plot the total costs line and the total revenues line. Their point of intersection is the breakeven point. We need only two points to plot each line if each is assumed to be linear.
 - Total costs line. This line is the sum of the fixed costs and the variable costs. Fixed costs are €2000 at all output levels within the relevant range. To plot fixed costs, measure €2000 on the vertical axis (point A) and extend a line horizontally. Variable costs are €120 per unit. To plot the total costs line, use as one point the €2000 fixed costs at 0 output units (point A). Select a second point by choosing any other convenient output level (say, 40 units) and determining the corresponding total costs. The total variable costs at this output level are €4800 (40 x €120). Fixed costs are €2000 at all output levels within the relevant range. Hence, total costs at 40 units of output are €6800, which is point B in Exhibit 8.1. The total costs line is the straight line from point A passing through point B.
 - Total revenues line. One convenient starting point is zero revenues at the zero output level, which is point C in Exhibit 8.1. Select a second point by choosing any other convenient output level and determining its total revenues. At 40 units of output total revenues are €8000 (40 x €200), which is point D in Exhibit 8.1. The total revenues line is the straight line from point C passing through point D.



The Breakeven Point: the Graph Method

- The breakeven point is where the total revenues line and the total costs line intersect. At this point, total revenues equal total costs.



*Slope of the total cost line is the variable cost per unit = €120.

† Slope of the total revenue line is the selling price = €200.



Target Operating Profit

- Let us introduce a profit element by asking the following question: How many units must be sold to earn an operating profit of €1200? The equation method provides a straightforward way to answer this question. Let QT be the number of units sold to earn the target operating profit:

Revenues – Variable Costs – Fixed Costs = Target Operating Profit

$$€200QT - €120QT - €2000 = €1200$$

$$€80QT = €2000 + €1200$$

$$€80QT = €3200$$

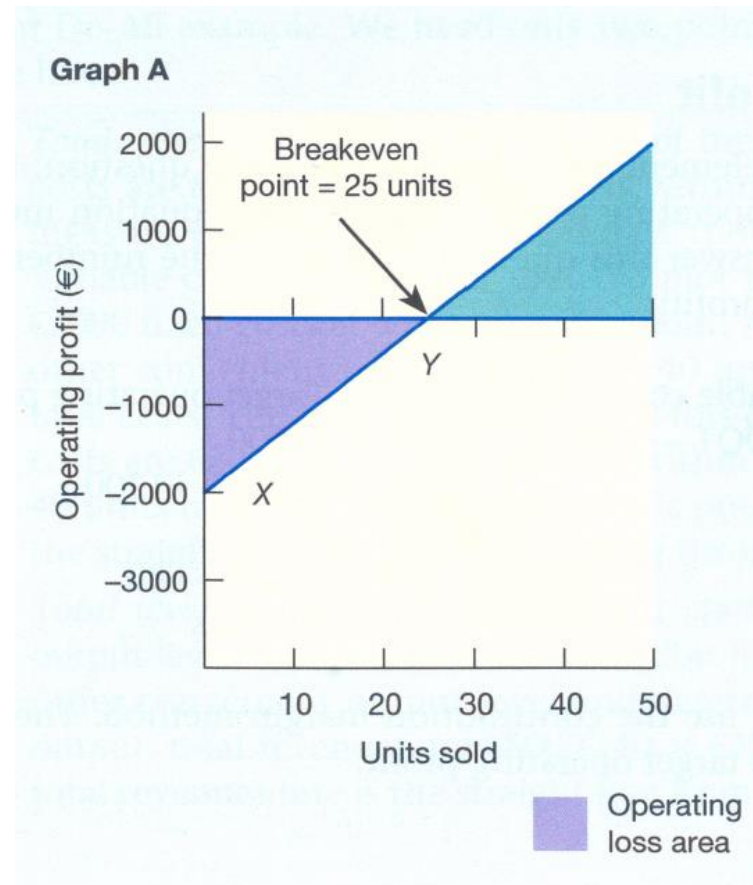
$$QT = €3200 \div €80 = 40 \text{ units.}$$

Proof: Revenues, €200 x 40	€ 8000
Variable costs, € 120 x 40	4800
Contribution margin, €80 x 40	3200
Fixed costs	2000
Operating profit	€ 1200



The Profit-Volume Graph

- A Profit-Volume (PV) graph shows the impact on operating profit of changes in the output level.





Impact of Income Taxes

- Recall our previous equation method:
 - Revenues – Variable costs – Fixed costs = Operating profit
- We now introduce income tax effects:
 - Target in profit = (Operating Profit) – [(Operating profit) x (Tax rate)]
 - Target net profit = (Operating profit) x (1 – Tax rate)
 - Operating profit = $\frac{\text{Target net profit}}{1 - \text{Tax rate}}$
- So, taking income taxes into account, the equation method yields:
 - Revenues – Variables costs – Fixed costs = $\frac{\text{Target net profit}}{1 - \text{Tax rate}}$



Impact of Income Taxes

- Assume the following income statement:

Proof: Revenues, €200 x 50	€ 10000
Variable costs, € 120 x 50	<u>6000</u>
Contribution margin	4000
Fixed costs	<u>2000</u>
Operating profit	2000
Income taxes, €2000 x 0,40	<u>800</u>
Net profit	€1200

- What number of units must be sold to earn a net profit of €1200, assuming operating profit is taxed at a rate of 40%?

$$\text{Operating profit} = \frac{\text{Target net profit}}{1 - \text{Tax rate}}$$

$$€200Q - €120Q - €2000 = \frac{€1680}{1 - 0.40}$$

$$€80Q - €2000 = €2800$$

$$€80Q = €4800$$

$$Q = €4800 \div €80 = 60 \text{ units}$$



Contribution Margin and Gross Margin

- Contribution margin = Revenues – All variable costs
Gross margin = Revenues – Cost of goods sold
- Cost of goods sold in the merchandising sector is made up of goods purchased for resale.
- Cost of goods sold in the manufacturing costs (including fixed manufacturing costs).
- Service-sector companies can calculate a contribution margin figure but not a gross margin figure.
- Service-sector companies do not have a cost of goods sold item in their income statement.



Decision Making in the Short Term

- The most important decision-making concepts are relevant costs and relevant revenues.
- Relevant costs are those expected future costs that differ among alternative courses of action.
- The two key aspects to this definition are that the costs must occur in the future and that they must differ among the alternative courses of action.
- We focus on the future because every decision deals with the future – nothing can be done to alter the past.
- Also, the future costs must differ among the alternatives because if they do not, there will be no difference in costs no matter what decision is made. Likewise, relevant revenues are those expected future revenues that differ among alternative courses of action.
- Topics:
 - One-off special orders
 - Product-mix decisions
 - Make-or-buy decisions



One-off Special Orders: Example

- ABC manufactures quality bath towels at its highly automated Heidelberg plant. The plant has a production capacity of 48 000 towels each month.
- Current monthly production is 30 000 towels. Retail department stores account for all existing sales.
- Expected results for the coming month (August) are (Note that these amounts are predictions.):

Budgeted income statement for August, absorption-costing format for Huber GmbH			
	Total		Per unit
Sales (30 000 towels x € 20)	€600 000		€20
Cost of goods sold	<u>360 000</u>		<u>12</u>
Gross margin (gross profit)	240 000		8
Marketing costs	<u>210 000</u>		<u>7</u>
Operating profit	<u>€ 30 000</u>		<u>€1</u>



One-off Special Orders: Example

- The manufacturing costs per unit of €12 consist of direct materials €6 (all variable), direct manufacturing labour €2 (€0,50 of which is variable), and manufacturing overhead €4 (€1 of which is variable).
- The marketing costs per unit are €7 (€5 of which is variable). Huber ABC has no R&D costs or product-design costs. Marketing costs include distribution costs and customer-service costs.
- A luxury hotel chain offers to buy 5000 towels per month at €11 a towel for each of the next three months. No subsequent sales to this customer are anticipated. No marketing costs will be necessary for the 5000-unit one-off special order. The acceptance of this special order is not expected to affect the selling price or the quantity of towels sold to regular customers.
- Should ABC accept the hotel chain's offer?



One-off Special Orders: Example

Comparative income statements for August, contribution income statement format for Huber GmbH				
	Without one-off special order 30 000 units		With one-off special order 35 000 units	Difference, 5000 units
	per unit	Total	Total	Total
Sales	<u>€20.00</u>	€600000	<u>€655000</u>	<u>€55000</u> [‡]
Variable costs				
Manufacturing	7.50 [*]	225000	262500	37500 [§]
Marketing	5.00	150 000	150 000	-#
Total variable costs	<u>12.50</u>	<u>375 000</u>	<u>412 500</u>	<u>37 500</u>
Contribution margin	<u>7.50</u>	<u>225 000</u>	<u>242 500</u>	<u>17 500</u>
Fixed costs				
Manufacturing	4.50 [†]	135 000	135 000	-#
Marketing	2.00	60 000	60 000	-#
Total fixed costs	<u>6.50</u>	<u>195 000</u>	<u>195 000</u>	-
Operating profit	<u>€1.00</u>	<u>€30 000</u>	<u>€47 500</u>	<u>€17 500</u>

* Variable manufacturing costs = direct materials, €6 + direct manufacturing labour, €0,50 + manufacturing overhead, €1 = €7.50



One-off Special Orders: Example

- Therefore:
 - The relevant costs are the expected future costs that differ between the alternatives – the variable manufacturing costs of €37 500 ($€7.50$ per unit \times 5000 units).
 - The fixed manufacturing costs and all marketing costs (including variable marketing costs) are irrelevant in this case; they will not change in total whether or not the special order is accepted.
 - Therefore, the only relevant items here are sales revenues and variable manufacturing costs. Given the €11 relevant revenue per unit (the special-order price) and the €7.50 relevant costs per unit. Huber would gain an additional €17 500 [$(€ 11.00 - €7.50) \times 5000$] in operating profit per month by accepting the special order.



Contribution Margin and Gross Margin

- Contribution margin = Revenues – All variable costs
Gross margin = Revenues – Cost of goods sold
- Cost of goods sold in the merchandising sector is made up of goods purchased for resale.
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Product-mix Decisions Under Capacity Constraints

- Companies with capacity constraints must also often decide which products to make and in what quantities.
- When a multiple-product plant operates at full capacity, managers must often make decisions regarding which products to emphasize.
- These decisions frequently have a short-run focus.
- Assume the following:

	Snowmobile engine	Boat engine
Selling price	€800	€1000
Variable costs per unit	560	625
Contribution margin per unit	<u>€240</u>	<u>€375</u>
Contribution margin ratio	30%	37,5%

- At first glance, boat engines appear more profitable than snowmobile engines.
- The product to be emphasized, however, is not necessarily the product with the higher individual contribution margin per unit or contribution margin percentage.
- Rather, managers should aim for the **highest contribution margin per unit of the constraining factor**- that is, the scarce, limiting or critical factor.



Product-mix Decisions Under Capacity Constraints

- Assume that only 600 machine-hours are available daily for assembling engines. Additional capacity cannot be obtained in the short run.
- The constraining factor, then, is machine-hours. It takes 2 machine-hours to produce one snowmobile engine and 5 machine-hours to produce one boat engine.

	Snowmobile engine	Boat engine
Contribution margin per engine	€240	€375
Machine-hours required to produce one engine	2 machine-hours	5 machine-hours
Contribution margin per machine-hour ($240 \div 2$; $375 \div 5$)	€120	€75
Total contribution margin for 600 machine-hours ($€120 \times 600$; $€75 \times 600$)	€72 000	€45 000

- Producing snowmobile engines contributes more margin per machine-hour, which is the constraining factor in this example. Therefore, choosing to emphasize snowmobile engines is the correct decision.



Outsourcing and Make-or-buy Decisions

- We now consider the strategic decision of whether a company should make a part or buy it from a supplier. We again assume idle capacity.
- Outsourcing is the process of purchasing goods and services from outside vendors rather than producing the same goods or providing the same services within the organization (which is called insourcing).
- Outsourcing is an increasingly common practice.
- Decisions about whether a producer of goods or services will insource or outsource are also called make-or-buy decisions. Sometimes qualitative factors dictate management's make-or-buy decision.
- Algorithm:
 - Identify the new variable costs that we would incur if we outsource.
 - Identify the variable costs that would disappear if we outsource.
 - Identify the fixed costs that we could avoid if we outsource.



Outsourcing or Make-or-Buy Decision: Example

- Thor Co. manufactures 20,000 of part 457 that is currently used in one of its products. The costs to make this part are:

Direct materials per unit	\$ 9,00
Direct labor per unit	5,00
Variable overhead per unit	1,00
Fixed overhead	180.000
Allocated common costs	100.000

- Fixed manufacturing overhead is the cost of leasing and operating the equipment necessary to produce part 457.
- Thor Co. manufactures 20,000 of part 457 that is currently used in one of its products. The costs per unit to make this part are:

Direct materials	\$ 9,00
Direct labor	5,00
Variable overhead	1,00
Fixed overhead ($\$180,000 \div 20,000$)	9,00
Common costs ($\$100,000 \div 20,000$)	5,00
Unit cost	<u>\$ 29,00</u>



Outsourcing or Make-or-Buy Decision: Example

- Common costs are allocated on the basis of direct labor hours.
- Total unit cost of \$29 is based on 20,000 parts produced each year.
- An outside supplier has offered to provide the 20,000 parts at a cost of \$25 per part.

- Should we accept the supplier's offer?



Outsourcing or Make-or-Buy Decision: Example

Make-or-buy analysis - 20,000 units

	<u>Make part</u>	<u>Buy part</u>	<u>Difference</u>
Direct costs:			
Direct materials	\$ 180.000		
Labor	100.000		
Variable overhead	20.000		
Fixed overhead			
Common costs			
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Annotations:

- $20,000 \times \$5 \text{ per unit}$ (points to the total Make part direct costs)
- $20,000 \times \$1 \text{ per unit}$ (points to the Buy part direct costs)
- $20,000 \times \$9 \text{ per unit}$ (points to the Difference column)



Outsourcing or Make-or-Buy Decision: Example

Make-or-buy analysis - 20,000 units

	<u>Make part</u>	<u>Buy part</u>	<u>Difference</u>
Direct costs:			
Direct materials	\$ 180.000		
Labor	100.000		
Variable overhead	20.000		
Fixed overhead	180.000		
Common costs	100.000		
	<u>\$ 580.000</u>		

20,000 × \$29 per unit



Outsourcing or Make-or-Buy Decision: Example

Make-or-buy analysis - 20,000 units

	<u>Make part</u>	<u>Buy part</u>	<u>Difference</u>
Direct costs:			
Direct materials	\$ 180.000	\$ 500.000	\$ 320.000
Labor	100.000		(100.000)
Variable overhead	20.000		(20.000)
Fixed overhead	180.000		(180.000)
Common costs	<u>100.000</u>	<u>100.000</u>	-
	<u>\$ 580.000</u>	<u>\$ 600.000</u>	<u>\$ 20.000</u>

20,000 × \$25 purchase price

The common costs remain unchanged.



Outsourcing or Make-or-Buy Decision: Example

Make-or-buy analysis - 20,000 units

	Make part	Buy part	Difference
Direct costs:			
Direct materials	\$ 180.000	\$ 500.000	\$ 320.000
Labor	100.000		(100.000)
Variable overhead	20.000		(20.000)
Fixed overhead	180.000		(180.000)
Common costs	100.000	100.000	-
	<u>\$ 580.000</u>	<u>\$ 600.000</u>	<u>\$ 20.000</u>

Should we make or buy part 457?

What is the relevant unit cost of making part 457?
Relevant costs are costs to be incurred at some future time and that differ for each option available to the decision maker.

Direct materials	\$ 9,00
Direct labor	5,00
Variable overhead	1,00
Fixed overhead ($\$180,000 \div 20,000$)	9,00
Total relevant unit cost	\$24,00

Advantage of making
20,000 units \times ($\$25.00 - \24.00) = \$20,000



Outsourcing or Make-or-Buy Decision: Example

If Thor could use the space currently being used to make Part 457 for another purpose, resulting in a cost savings of \$45,000, would you change your decision?

Yes. The cost savings of \$45,000 overcomes the \$20,000 disadvantage of buying. Now there is a \$25,000 advantage to buying.

The real issue is the most profitable use of the space.



Customer Profitability and Relevant Costs

- In addition to making choices among products, companies must often decide whether they should add some customers and drop others.
- This section illustrates relevant-revenue and relevant-cost analysis when different cost drivers are identified for different activities.
- Each customer is considered as a cost object.



Customer Profitability and Relevant Costs

Example: Assume that the analysis refers on customer profitability at Imbro-Glio, the Naples sales office of Papa-Geno Srl, a whole-saler of specialized furniture.

	Lucrezia	Borgia	Rigo- Letto	Total
Sales	<u>€500 000</u>	<u>€300 000</u>	<u>€400 000</u>	<u>€1 200 000</u>
Cost of goods sold	370 000	220 000	330 000	920 000
Materials handling labour	41 000	18 000	33 000	92 000
Materials handling equipment cost written off as depreciation	10 000	6 000	8 000	24 000
Rent	14 000	8 000	14 000	36 000
Marketing support	11 000	9 000	10 000	30 000
Purchase orders and delivery processing	13 000	7 000	12 000	32 000
General administration	20 000	12 000	16 000	48 000
Total operating costs	<u>479 000</u>	<u>280 000</u>	<u>423 000</u>	<u>1 182 000</u>
Operating profit	<u>€21 000</u>	<u>€20 000</u>	<u>€(23 000)</u>	<u>€18 000</u>

Drop the customer (because of loss)?



Customer Profitability and Relevant Costs

- The key question is: What are the relevant costs and relevant revenues?
- The following information about the effect of reducing various activities related to the Rigo-Letto account is available.
 - Dropping the Rigo-Letto account will save cost of goods sold, materials handling labour, marketing support, purchase-order and delivery processing costs incurred on the Rigo-Letto account.
 - Dropping the Rigo-Letto account will mean that the warehouse space currently occupied by products for Rigo-Letto and the materials handling equipment used to move them will become idle.
 - Dropping the Rigo-Letto account will have no effect on fixed general administration costs.



Customer Profitability and Relevant Costs

	Amount of total revenues and total costs		Difference: incremental (loss in revenue) and savings in costs from dropping Rigo-Letto account
	Keep Rigo-Letto account	Drop Rigo-Letto account	
Sales	<u>€1 200 000</u>	<u>€800 000</u>	<u>€(400 000)</u>
Cost of goods sold	920 000	590 000	330 000
Materials handling labour	92 000	59 000	33 000
Materials handling equipment cost written off as depreciation	24 000	24 000	0
Rent	36 000	36 000	0
Marketing support	30 000	20 000	10 000
Purchase orders and delivery processing	32 000	20 000	12 000
General administration	48 000	48 000	0
Total operating costs	<u>118 200</u>	<u>797 000</u>	<u>385 000</u>
Operating profit (loss)	<u>€18 000</u>	<u>€3 000</u>	<u>€(15 000)</u>