CHAPTER 19

Cost Behavior and Cost-Volume-Profit Analysis

Financial and Managerial Accounting 13e

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Learning Objectives

- **LO1**: Classify costs as variable costs, fixed costs, or mixed costs.
- **LO2**: Compute the contribution margin, the contribution margin ratio, and the unit contribution margin.
- **LO3**: Determine the break-even point and sales necessary to achieve a target profit.
- **LO4**: Using a cost-volume-profit chart and a profit-volume chart, determine the break-even point and sales necessary to achieve a target profit.
- **LO5**: Compute the break-even point for a company selling more than one product, the operating leverage, and the margin of safety.

Cost Behavior

- Cost behavior is the manner in which a cost changes as a related activity changes.
- Understanding the behavior of a cost depends on the following:
  - Identifying the activities that cause the cost to change.
    - These activities are called **activity bases** (or activity drivers).
  - Specifying the range of activity over which the changes in the cost are of interest.
    - This range of activity is called the **relevant range**.
- Costs are normally classified as variable costs, fixed costs, or mixed costs.

Variable Costs
(slide 1 of 2)

- **Variable costs** are costs that vary in proportion to changes in the activity base.
- When the activity base is units produced, direct materials and direct labor costs are normally classified as variable costs.

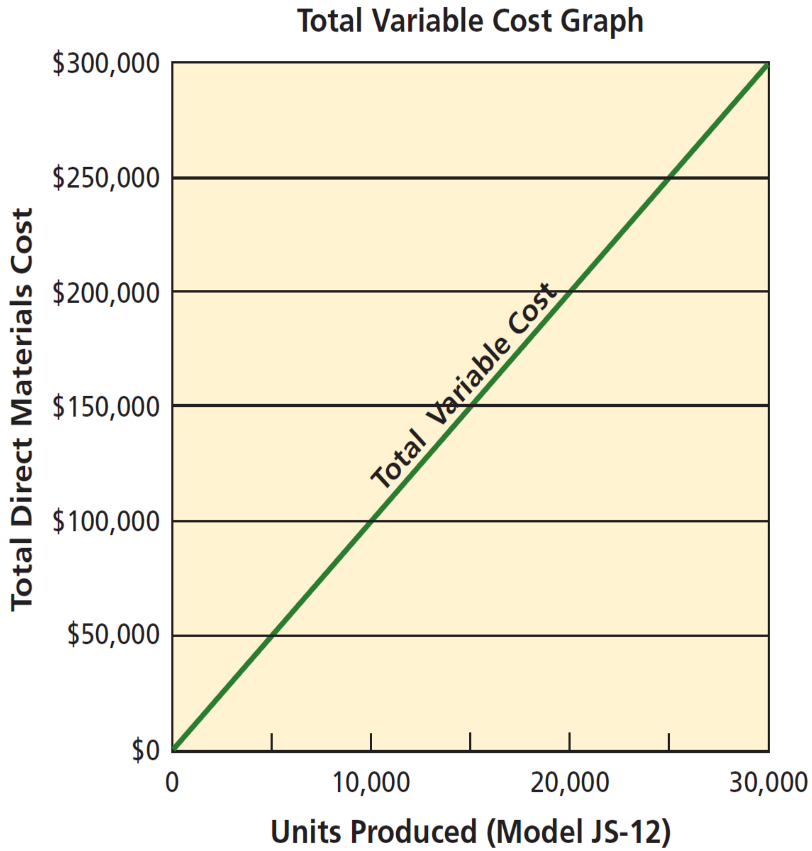
Variable Costs
(slide 2 of 2)

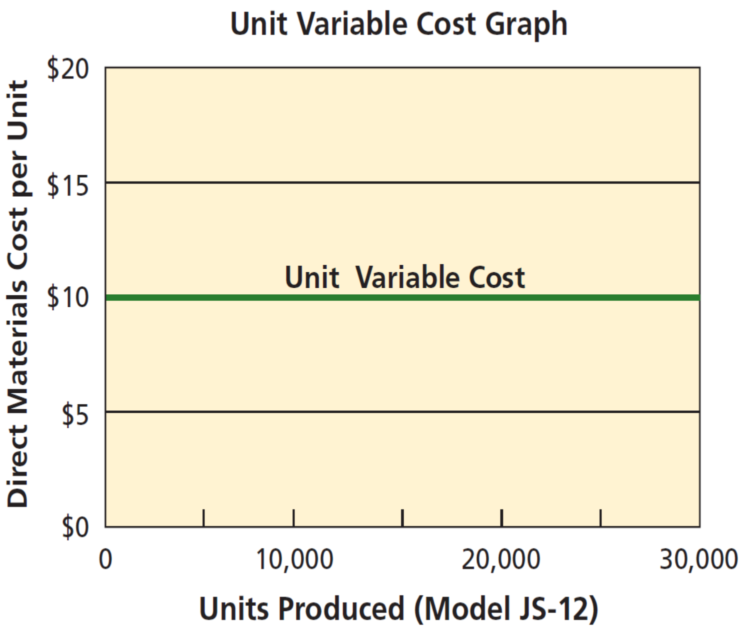
- Assume that Jason Sound Inc. produces stereo systems. The parts for the stereo systems are purchased from suppliers for $10 per unit and are assembled by Jason Sound. For Model JS-12, the direct materials costs for the relevant range of 5,000 to 30,000 units of production are as follows:

Number of Units of Model JS-12 Produced	Direct Materials Cost per Unit	Total Direct Materials Cost
5,000 units	$10	$ 50,000
10,000	10	100,000
15,000	10	150,000
20,000	10	200,000
25,000	10	250,000
30,000	10	300,000

- As shown, variable costs have the following characteristics:
  - Cost per unit remains the same regardless of changes in the activity base.
  - Total cost changes in proportion to changes in the activity base.

Variable Cost Graph





Variable Costs and Their Activity Bases

Type of Business	Cost	Activity Base
University	Instructor salaries	Number of classes
Passenger airline	Fuel	Number of miles flown
Manufacturing	Direct materials	Number of units produced
Hospital	Nurse wages	Number of patients
Hotel	Maid wages	Number of guests
Bank	Teller wages	Number of banking transactions

Fixed Costs
(slide 1 of 2)

- **Fixed costs** are costs that remain the same in total dollar amount as the activity base changes.
- When the activity base is units produced, many factory overhead costs such as straight-line depreciation are classified as fixed costs.

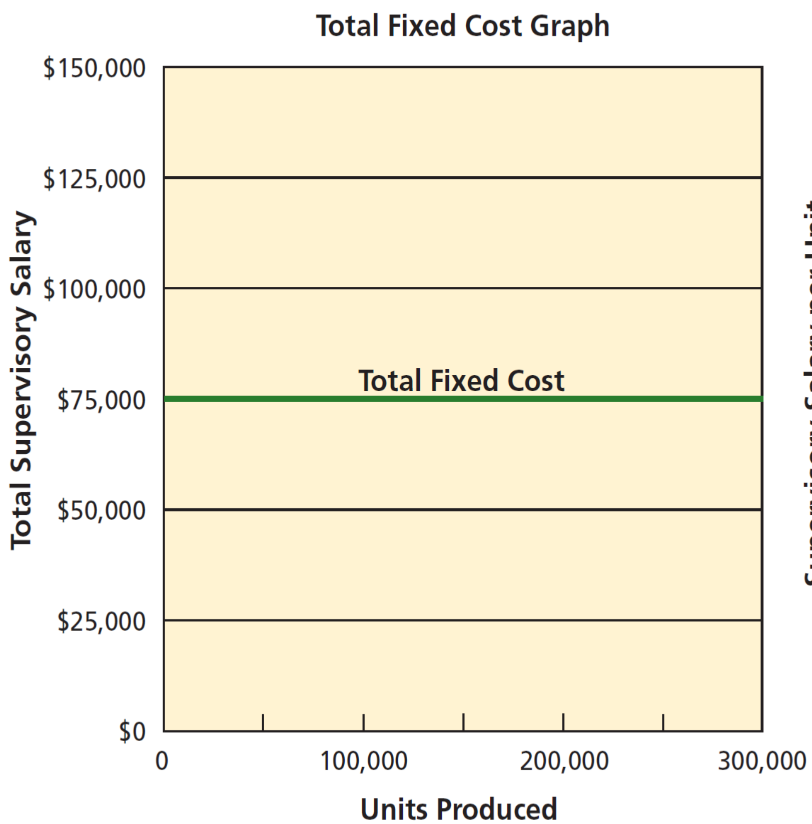
Fixed Costs
(slide 2 of 2)

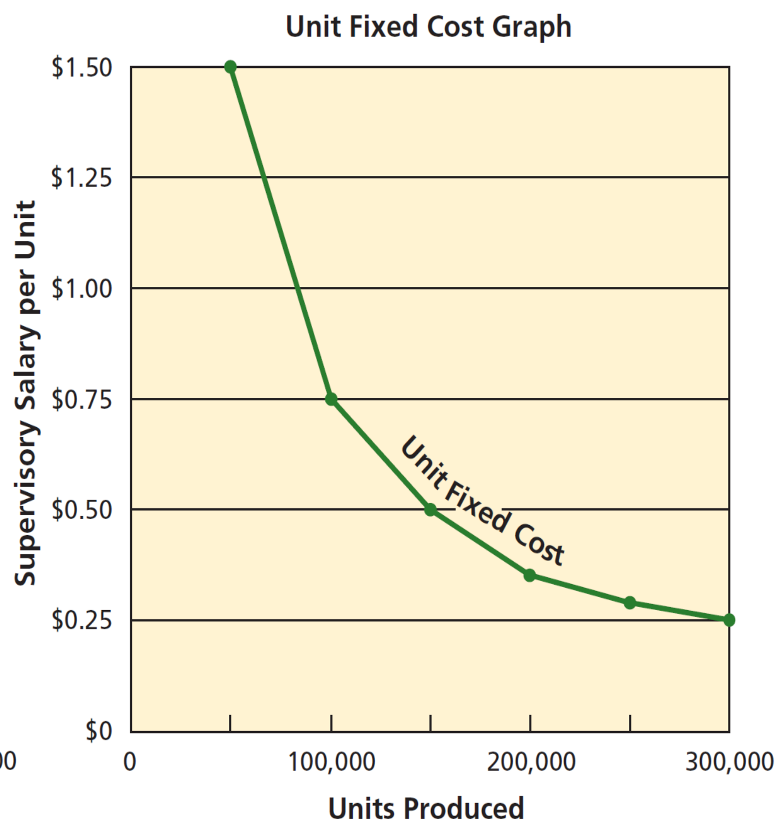
- Assume that Minton Inc. manufactures, bottles, and distributes perfume. The production supervisor is Jane Sovissi, who is paid $75,000 per year. For the relevant range of 50,000 to 300,000 bottles of perfume, the total fixed cost of $75,000 does not vary as production increases. As a result, the fixed cost per bottle decreases as the units produced increase. This is because the fixed cost is spread ov

Number of Bottles of Perfume Produced	Total Salary for Jane Sovissi	Salary per Bottle of Perfume Produced
50,000 bottles	$75,000	$1.500
100,000	75,000	0.750
150,000	75,000	0.500
200,000	75,000	0.375
250,000	75,000	0.300
300,000	75,000	0.250

- As shown, fixed costs have the following characteristics:
  - Cost per unit decreases as the activity level increases and increases as the activity level decreases.
  - Total cost remains the same regardless of changes in the activity base.

Fixed Cost Graphs





Fixed Costs and Their Activity Bases

Type of Business	Fixed Cost	Activity Base
University	Building (straight-line) depreciation	Number of students
Passenger airline	Airplane (straight-line) depreciation	Number of miles flown
Manufacturing	Plant manager salary	Number of units produced
Hospital	Property insurance	Number of patients
Hotel	Property taxes	Number of guests
Bank	Branch manager salary	Number of customer accounts

Mixed Costs

- **Mixed costs** are costs that have characteristics of both a variable and a fixed cost. Mixed costs are sometimes called semivariable or semifixed costs.

Mixed Costs
(slide 2 of 7)

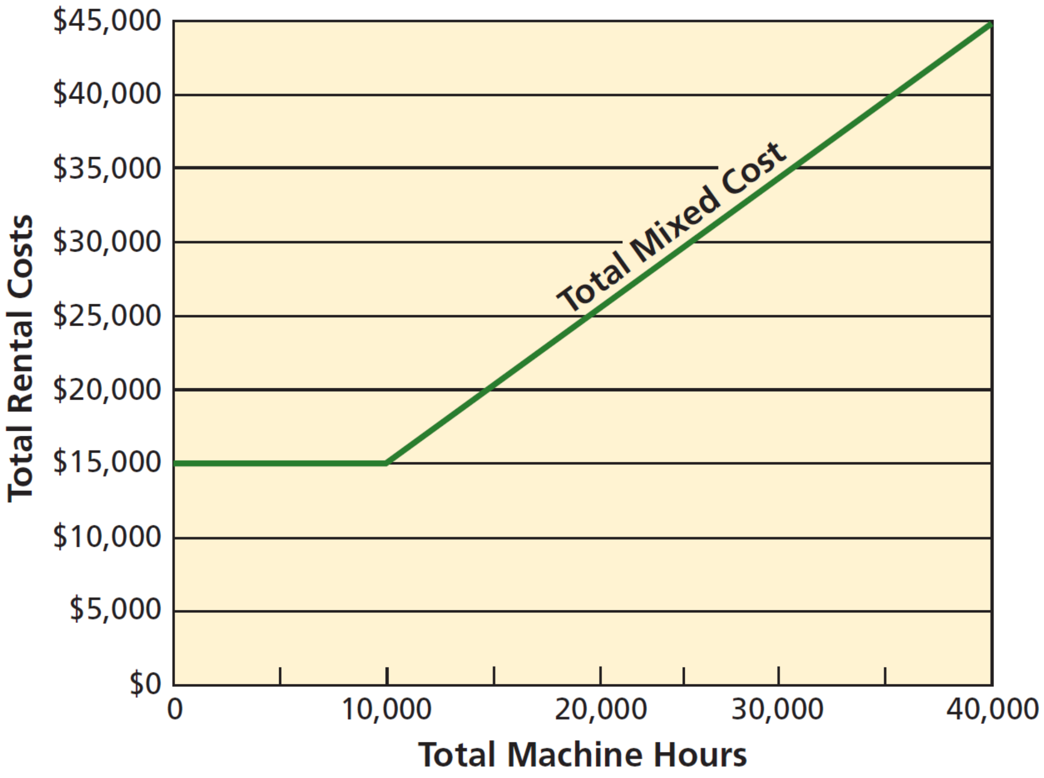
- Assume that Simpson Inc. manufactures sails, using rented machinery. The rental charges are as fol

Rental Charge = $15,000 per year + $1 for each hour used in excess of 10,000 hours

- The rental charges for various hours used within the relevant range of 8,000 hours to 40,000 hours a

Hours Used	Rental Charge
8,000 hours	$15,000
12,000	$17,000 {$15,000 + [(12,000 hrs. – 10,000 hrs.) × $1]}
20,000	$25,000 {$15,000 + [(20,000 hrs. – 10,000 hrs.) × $1]}
40,000	$45,000 {$15,000 + [(40,000 hrs. – 10,000 hrs.) × $1]}

Mixed Costs



$45,000
$40,000
$35,000
$30,000
$25,000
$20,000
$15,000
$10,000
$5,000
$0
Total Rental Costs
Total Mixed Cost
0
10,000
20,000
30,000
40,000
Total Machine Hours

Mixed Costs
(slide 3 of 7)

- The **high-low method** is a cost estimation method that may be used to separate mixed costs into their fixed and variable components.

Mixed Costs
(slide 4 of 7)

- Assume that the Equipment Maintenance Department of Kason Inc. incurred the following costs during the past five months:

	Units Produced	Total Cost
June	1,000 units	$45,550
July	1,500	52,000
August	2,100	61,500
September	1,800	57,500
October	750	41,250

- The number of units produced is the activity base, and the relevant range is the units produced between June and October.

Mixed Costs
(slide 5 of 7)

- For Kason, the difference between the units produced and the total costs at the highest and lowest levels of production are as follows:

	Units Produced	Total Cost
Highest level	2,100 units	$61,500
Lowest level	750	41,250
Difference	1,350 units	$20,250

- The total fixed cost does not change with changes in production.
  - Thus, the $20,250 difference in the total cost is the change in the total variable cost.
    - Dividing this difference of $20,250 by the difference in production is an estimate of the variable cost per unit. For Kason, this estimate is computed as follows:

$$\text{Variable Cost per Unit} = \frac{\text{Difference in Total Cost}}{\text{Difference in Units Produced}}$$

$$= \frac{\$20,250}{1,350 \text{ units}} = \$15 \text{ per unit}$$

Mixed Costs
(slide 6 of 7)

- The fixed cost is estimated by subtracting the total variable costs from the total costs for the units produced, as follows:

$$\text{Fixed Cost} = \text{Total Costs} - (\text{Variable Cost per Unit} \times \text{Units Produced})$$

- The fixed cost is the same at the highest and the lowest levels of production, as follows for Kason:

Highest level (2,100 units)

$$\begin{aligned}\text{Fixed Cost} &= \text{Total Costs} - (\text{Variable Cost per Unit} \times \text{Units Produced})\\ &= \$61,500 - (\$15 \times 2,100 \text{ units})\\ &= \$61,500 - \$31,500\\ &= \$30,000\end{aligned}$$

Lowest level (750 units)

$$\begin{aligned}\text{Fixed Cost} &= \text{Total Costs} - (\text{Variable Cost per Unit} \times \text{Units Produced})\\ &= \$41,250 - (\$15 \times 750 \text{ units})\\ &= \$41,250 - \$11,250\\ &= \$30,000\end{aligned}$$

Mixed Costs
(slide 7 of 7)

- Using the variable cost per unit and the fixed cost, the total equipment maintenance cost for Kason can be computed for various levels of production as follows:

$$\begin{aligned}\text{Total Cost} &= (\text{Variable Cost per Unit} \times \text{Units Produced}) + \text{Fixed Costs}\\ &= (\$15 \times \text{Units Produced}) + \$30{,}000\end{aligned}$$

  - For example, the estimated cost of 2,000 units of production is $60,000, computed as follows:

$$\begin{aligned}\text{Total Cost} &= (\$15 \times \text{Units Produced}) + \$30{,}000\\ &= (\$15 \times 2{,}000\ \text{units}) + \$30{,}000 = \$30{,}000 + \$30{,}000\\ &= \$60{,}000\end{aligned}$$

Example Exercise

High-Low Method

The manufacturing costs of Alex Industries for the first three months of the year follow:

	Total Cost	Production
January	$ 80,000	1,000 units
February	125,000	2,500
March	100,000	1,800

Using the high-low method, determine (a) the variable cost per unit and (b) the total fixed cost.

a. $30 per unit = ($125,000 – $80,000) ÷ (2,500 – 1,000)

b. $50,000 = $125,000 – ($30 × 2,500), or $80,000 – ($30 × 1,000)

Variable and Fixed Cost Behavior

	Effect of Changing Activity Level	
Cost	**Total Amount**	**Per-Unit Amount**
Variable	Increases and decreases proportionately with activity level.	Remains the same regardless of activity level.
Fixed	Remains the same regardless of activity level.	Increases and decreases inversely with activity level.

Variable, Fixed, and Mixed Cost

Variable Costs	Fixed Costs	Mixed Costs
• Direct materials	• Straight-line depreciation	• Quality Control Department salaries
• Direct labor	• Property taxes	• Purchasing Department salaries
• Electricity expense	• Production supervisor salaries	• Maintenance expenses
• Supplies	• Insurance expense	• Warehouse expenses

Summary of Cost Behavior Concepts

- One method of reporting variable and fixed costs is called **variable costing** or direct costing.
  - Under variable costing, only the variable manufacturing costs (direct materials, direct labor, and variable factory overhead) are included in the product cost.
  - The fixed factory overhead is treated as an expense of the period in which it is incurred.

Cost-Volume-Profit Relationships

- **Cost-volume-profit analysis** is the examination of the relationships among selling prices, sales and production volume, costs, expenses, and profits.
- Some of the ways cost-volume-profit analysis may be used include the following:
  - Analyzing the effects of changes in selling prices on profits
  - Analyzing the effects of changes in costs on profits
  - Analyzing the effects of changes in volume on profits
  - Setting selling prices
  - Selecting the mix of products to sell
  - Choosing among marketing strategies

Contribution Margin
(slide 1 of 2)

- **Contribution margin** is the excess of sales over variable costs, computed as follows:

  Contribution Margin = Sales – Variable Costs

- Contribution margin covers fixed costs. Once the fixed costs are covered, any additional contribution margin increases income from operations.

Contribution Margin
(slide 2 of 2)

- Assume the following data for Lambert Inc.:

Sales	50,000 units
Sales price per unit	$20 per unit
Variable cost per unit	$12 per unit
Fixed costs	$300,000

Contribution Margin Income Statement Format

Sales (50,000 units × \$20)	\$1,000,000
Variable costs (50,000 units × \$12)	600,000
Contribution margin (50,000 units × \$8)	\$ 400,000
Fixed costs	300,000
Income from operations	\$ 100,000

Contribution Margin Ratio
(slide 1 of 3)

- The **contribution margin ratio**, sometimes called the profit-volume ratio, indicates the percentage of each sales dollar available to cover fixed costs and to provide income from operations.
- The contribution margin ratio is computed as follows:

$$\text{Contribution Margin Ratio} = \frac{\text{Contribution Margin}}{\text{Sales}}$$

  - The contrib... nc. is computed as follows:

$$\text{Contribution Margin Ratio} = \frac{\$400{,}000}{\$1{,}000{,}000} = 40\%$$

Contribution Margin Ratio
(slide 2 of 3)

- The contribution margin ratio is most useful when the increase or decrease in sales volume is measured in sales dollars. In this case, the change in sales dollars multiplied by the contribution margin ratio equals the change in income from operations, computed as follows:

$$\text{Change in Income from Operations} = \text{Change in Sales Dollars} \times \text{Contribution Margin Ratio}$$

  - For example, if Lambert adds $80,000 in sales from the sale of an additional 4,000 units, its income from operations will increase by $32,000, computed as follows:

$$\text{Change in Income from Operations} = \text{Change in Sales Dollars} \times \text{Contribution Margin Ratio}$$
$$\text{Change in Income from Operations} = \$80{,}000 \times 40\% = \$32{,}000$$

Contribution Margin Ratio
(slide 3 of 3)

- The preceding analysis is confirmed by the contribution margin income statement of Lambert that follows:

Sales (54,000 units × $20)	$1,080,000
Variable costs (54,000 units × $12)	648,000*
Contribution margin (54,000 units × $8)	$ 432,000**
Fixed costs	300,000
Income from operations	$ 132,000

*$1,080,000 × 60%
**$1,080,000 × 40%

Unit Contribution Margin

(slide 1 of 3)

- The unit contribution margin is useful for analyzing the profit potential of proposed decisions.
- The **unit contribution margin** is computed as:

  Unit Contribution Margin = Sales Price per Unit – Variable Cost per Unit

  - If Lambert Inc.'s unit selling price is \$20 and its variable cost per unit is \$12, the unit contribution margi

Unit Contribution Margin = Sales Price per Unit – Variable Cost per Unit
Unit Contribution Margin = \$20 – \$12 = \$8

Unit Contribution Margin
(slide 2 of 3)

- The unit contribution margin is most useful when the increase or decrease in sales volume is measured in sales units (quantities). In this case, the change in sales volume (units) multiplied by the unit contribution margin equals the change in income from operations, computed as follows:

$$\text{Change in Income from Operations} = \text{Change in Sales Units} \times \text{Unit Contribution Margin}$$

  - Assume that Lambert's sales could be increased by 15,000 units, from 50,000 units to 65,000 units. The increase in Lambert's income from operations is computed as follows:

$$\text{Change in Income from Operations} = \text{Change in Sales Units} \times \text{Unit Contribution Margin}$$
$$\text{Change in Income from Operations} = 15{,}000 \text{ units} \times \$8 = \$120{,}000$$

Unit Contribution Margin
(slide 3 of 3)

- The preceding analysis is confirmed by the contribution margin income statement of Lambert that follows:

Sales (65,000 units × \$20)	\$1,300,000
Variable costs (65,000 units × \$12)	780,000
Contribution margin (65,000 units × \$8)	\$ 520,000
Fixed costs	300,000
Income from operations	\$ 220,000

Example Exercise

Molly Company sells 20,000 units at $12 per unit. Variable costs are $9 per unit, and fixed costs are $25,000. Determine the (a) contribution margin ratio, (b) unit contribution margin, and (c) income from operations.

a. 25% = ($12 – $9) ÷ $12, or ($240,000 – $180,000) ÷ $240,000

b. $3 per unit = $12 – $9

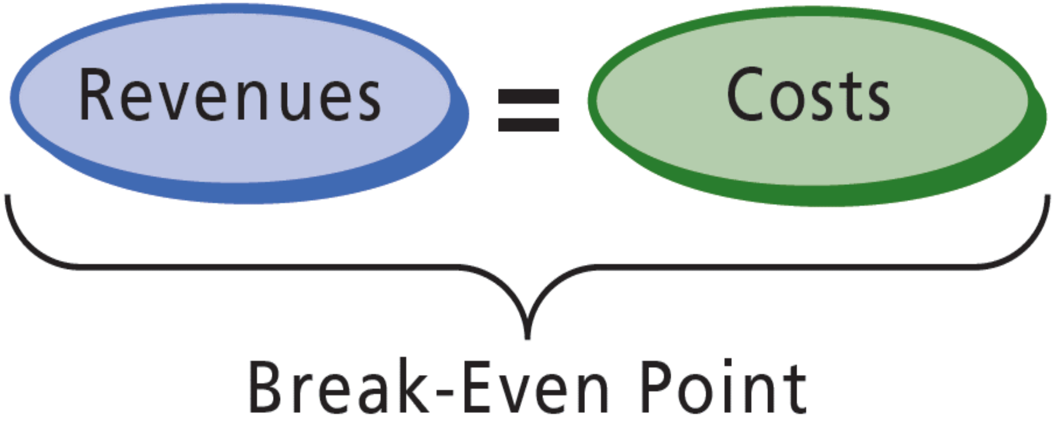
c.	Sales	$240,000	(20,000 units × $12 per unit)
	Variable costs	180,000	(20,000 units × $9 per unit)
	Contribution margin	$ 60,000	[20,000 units × ($12 – $9)]
	Fixed costs	25,000	
	Income from operations	$ 35,000	

Break-Even Point
(slide 1 of 5)

- The **break-even point** is the level of operations at which a company's revenues and expenses are equal.
- At break-even, a company reports neither income nor a loss from operations.
- The break even-point in sales units is computed as follows:

$$\text{Break-Even Sales (units)} = \frac{\text{Fixed Costs}}{\text{Unit Contribution Margin}}$$

Break-Even Point



Break-Even Point
(slide 2 of 5)

- Assume the following data for Baker Corporation:

Fixed costs	$90,000
Unit selling price	$25
Unit variable cost	15
Unit contribution margin	$10

- The break-even point for Baker is computed as follows:

$$\text{Break-Even Sales (units)} = \frac{\text{Fixed Costs}}{\text{Unit Contribution Margin}} = \frac{\$90{,}000}{\$10} = 9{,}000 \text{ units}$$

Break-Even Point
(slide 3 of 5)

- The following income statement for Baker verifies the break-even point of 9,000 units:

Sales (9,000 units × \$25)	\$225,000
Variable costs (9,000 units × \$15)	135,000
Contribution margin	\$ 90,000
Fixed costs	90,000
Income from operations	\$ 0

Break-Even Point
(slide 4 of 5)

- The break-even point in sales dollars can be determined directly as follows:

$$\text{Break-Even Sales (dollars)} = \frac{\text{Fixed Costs}}{\text{Contribution Margin Ratio}}$$

  - The contribution margin ratio can be computed using the unit contribution margin and unit selling price as follows:

$$\text{Contribution Margin Ratio} = \frac{\text{Unit Contribution Margin}}{\text{Unit Selling Price}}$$

Break-Even Point
(slide 5 of 5)

- The contribution margin ratio for Baker is computed as follows:

$$\text{Contribution Margin Ratio} = \frac{\text{Unit Contribution Margin}}{\text{Unit Selling Price}} = \frac{\$10}{\$25} = 40\%$$

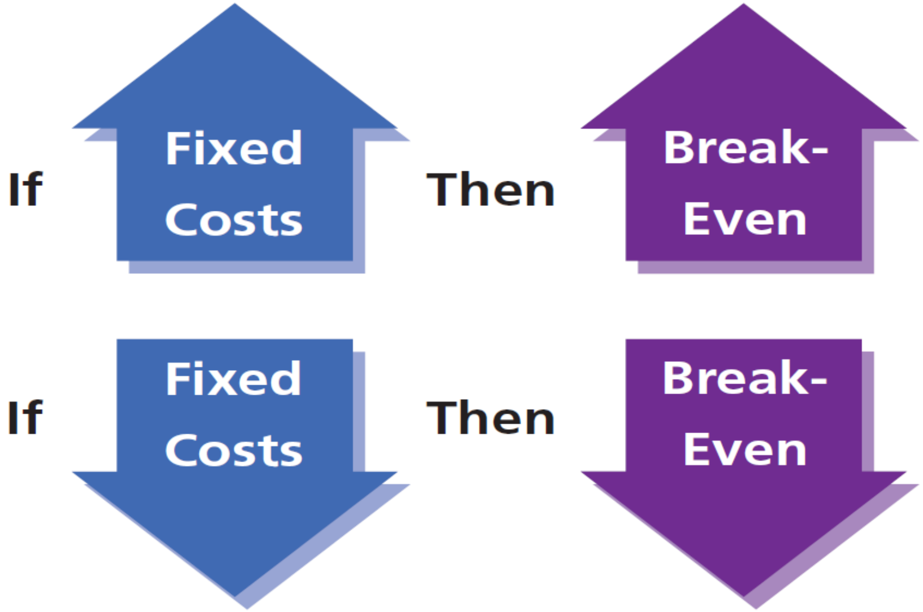
- Thus, the break-even sales dollars for Baker can be computed directly as follows:

$$\text{Break-Even Sales (dollars)} = \frac{\text{Fixed Costs}}{\text{Contribution Margin Ratio}} = \frac{\$90{,}000}{40\%} = \$225{,}000$$

Effect of Changes in Fixed Costs
(Slide 1 of 3)

- Fixed costs do not change in total with changes in the level of activity. However, fixed costs may change because of other factors such as advertising campaigns, changes in property tax rates, or changes in factory supervisors' salaries.
- Changes in fixed costs affect the break-even point as follows:
  - Increases in fixed costs increase the break-even point.
  - Decreases in fixed costs decrease the break-even point.

Effect of Change in Fixed Costs on Break-Even Point



Effect of Changes in Fixed Costs

(slide 2 of 3)

- Assume that Bishop Co. is evaluating a proposal to budget an additional $100,000 for advertising. The data for Bishop Co. follows:

	Current	Proposed
Unit selling price	$90	$90
Unit variable cost	70	70
Unit contribution margin	$20	$20
Fixed costs	$600,000	$700,000

Effect of Changes in Fixed Costs
(slide 3 of 3)

- Bishop's break-even point before the additional advertising expense of $100,000 is computed as follows:

$$\text{Break-Even Sales (units)} = \frac{\text{Fixed Costs}}{\text{Unit Contribution Margin}} = \frac{\$600{,}000}{\$20} = 30{,}000 \text{ units}$$

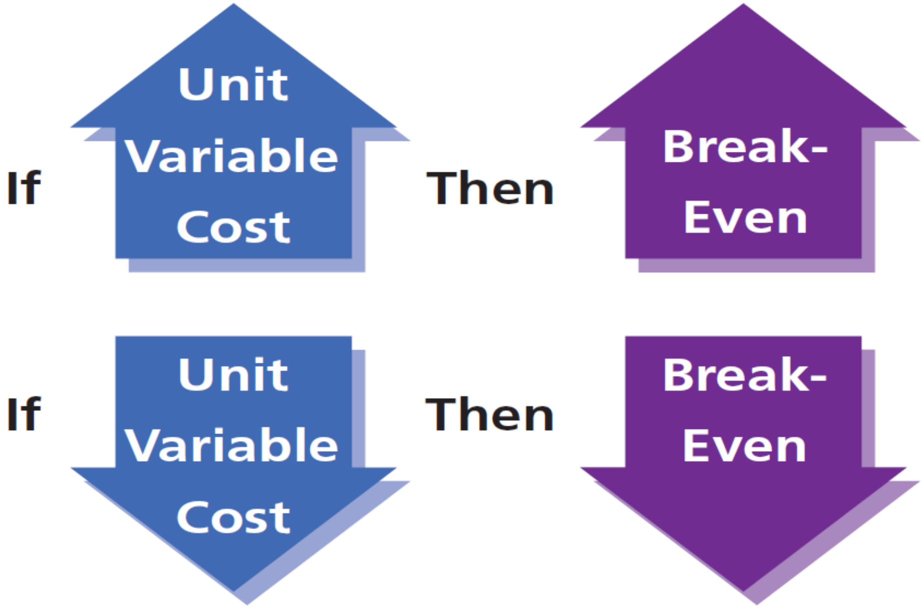
- Bishop's break-even point after the additional advertising expense of $100,000 is computed as follows:

$$\text{Break-Even Sales (units)} = \frac{\text{Fixed Costs}}{\text{Unit Contribution Margin}} = \frac{\$700{,}000}{\$20} = 35{,}000 \text{ units}$$

Effect of Changes in Unit Variable Costs
(slide 1 of 3)

- Unit variable costs do not change with changes in the level of activity. However, unit variable costs may be affected by other factors such as changes in the cost per unit of direct materials, changes in the wage rate for direct labor, or changes in the sales commission paid to salespeople.
- Changes in unit variable costs affect the break-even point as follows:
    - Increases in unit variable costs increase the break-even point.
    - Decreases in unit variable costs decrease the break-even point.

Effect of Change in Unit Variable Cost on Break-Even Point



Effect of Changes in Unit Variable Costs
(slide 2 of 3)

- Assume that Park Co. is evaluating a proposal to pay an additional 2% commission on sales to its salespeople as an incentive to increase sales. The data for Park follows:

	Current	Proposed
Unit selling price	$250	$250
Unit variable cost	145	150*
Unit contribution margin	$105	$100
Fixed costs	$840,000	$840,000

*$150 = $145 + (2% × $250 unit selling price).

Effect of Changes in Unit Variable Costs
(slide 3 of 3)

- Park's break-even point before the additional 2% commission is computed as follows:

$$\text{Break-Even Sales (units)} = \frac{\text{Fixed Costs}}{\text{Unit Contribution Margin}} = \frac{\$840,000}{\$105} = 8,000 \text{ units}$$

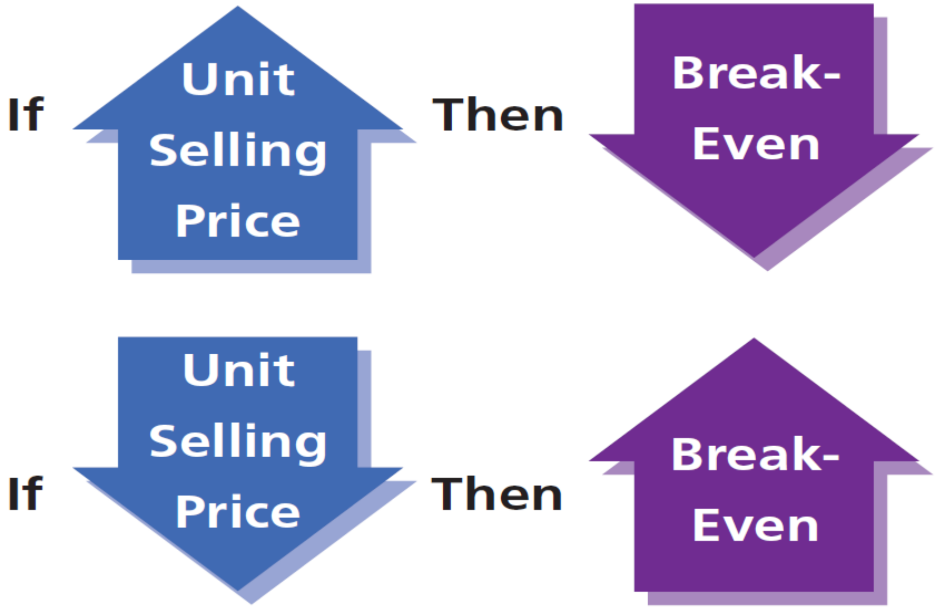
- Bishop's break-even point after the additional 2% commission is computed as follows:

$$\text{Break-Even Sales (units)} = \frac{\text{Fixed Costs}}{\text{Unit Contribution Margin}} = \frac{\$840,000}{\$100} = 8,400 \text{ units}$$

Effect of Changes in Unit Selling Price
(slide 1 of 3)

- Changes in the unit selling price affect the break-even point as follows:
    - Increases in the unit selling price decrease the break-even point.
    - Decreases in the unit selling price increase the break-even point.

Effect of Change in Unit Selling Price on Break-Even Point



Effect of Changes in Unit Selling Price
(slide 2 of 3)

- Assume that Graham Co. is evaluating a proposal to increase the unit selling price of a product from $50 to $60. The data for Graham follows:

	Current	Proposed
Unit selling price	$50	$60
Unit variable cost	30	30
Unit contribution margin	$20	$30
Fixed costs	$600,000	$600,000

Effect of Changes in Unit Selling Price
(slide 3 of 3)

- Graham's break-even point before price increase is computed as follows:

$$\text{Break-Even Sales (units)} = \frac{\text{Fixed Costs}}{\text{Unit Contribution Margin}} = \frac{\$600{,}000}{\$20} = 30{,}000 \text{ units}$$

- Graham's break-even point after price increase is computed as follows:

$$\text{Break-Even Sales (units)} = \frac{\text{Fixed Costs}}{\text{Unit Contribution Margin}} = \frac{\$600{,}000}{\$30} = 20{,}000 \text{ units}$$

Effects of Changes in Selling Price and Costs on Break-Even Point

Type of Change	Direction of Change	Effect of Change on Break-Even Sales
Fixed cost	↑	↑
	↓	↓
Unit variable cost	↑	↑
	↓	↓
Unit selling price	↑	↓
	↓	↑

Example Exercise

Nicolas Enterprises sells a product for $60 per unit. The variable cost is $35 per unit, while fixed costs are $80,000. Determine the (a) break-even point in sales units and (b) break-even point in sales units if the selling price were increased to $67 per unit.

a. 3,200 units = $80,000 ÷ ($60 – $35)

b. 2,500 units = $80,000 ÷ ($67 – $35)

Target Profit
(slide 1 of 4)

- The sales required to earn a target or desired amount of profit is determined by modifying the break-even equation as follows:

$$\text{Sales (units)} = \frac{\text{Fixed Costs} + \text{Target Profit}}{\text{Unit Contribution Margin}}$$

Target Profit
(slide 2 of 4)

- Assume the following data for Waltham Co.:

Fixed costs	$200,000
Target profit	100,000
Unit selling price	$75
Unit variable cost	45
Unit contribution margin	$30

- The sales necessary for Waltham to earn the target profit of $100,000 is computed as follows:

$$\text{Sales (units)} = \frac{\text{Fixed Costs} + \text{Target Profit}}{\text{Unit Contribution Margin}} = \frac{\$200{,}000 + \$100{,}000}{\$30} = 10{,}000 \text{ units}$$

Target Profit
(slide 3 of 4)

- The following income statement for Waltham verifies the computation on the previous slide:

Sales (10,000 units × $75)	$750,000
Variable costs (10,000 units × $45)	450,000
Contribution margin (10,000 units × $30)	$300,000
Fixed costs	200,000
Income from operations	$100,000 ← Target profit

Target Profit
(slide 4 of 4)

- As shown on the income statement for Waltham, sales of $750,000 are necessary to earn a target profit of $100,000. The sales of $750,000 needed to earn a target profit of $100,000 can be computed directly using the contribution margin ratio, computed as follows:

$$\text{Contribution Margin Ratio} = \frac{\text{Unit Contribution Margin}}{\text{Unit Selling Price}} = \frac{\$30}{\$75} = 40\%$$

$$\text{Sales (dollars)} = \frac{\text{Fixed Costs} + \text{Target Profit}}{\text{Contribution Margin Ratio}}$$

$$= \frac{\$200{,}000 + \$100{,}000}{40\%} = \frac{\$300{,}000}{40\%} = \$750{,}000$$

Example Exercise

Target Profit

Forest Company sells a product for $140 per unit. The variable cost is $60 per unit, and fixed costs are $240,000. Determine the (a) break-even point in sales units and (b) the sales units required to achieve a target profit of $50,000.

a. 3,000 units = $240,000 ÷ ($140 – $60)

b. 3,625 units = ($240,000 + $50,000) ÷ ($140 – $60)

Cost-Volume-Profit (Break-Even) Chart
(slide 1 of 5)

- A **cost-volume-profit chart**, sometimes called a break-even chart, graphically shows sales, costs, and the related profit or loss for various levels of units sold.

Cost-Volume-Profit (Break-Even) Chart
(slide 2 of 5)

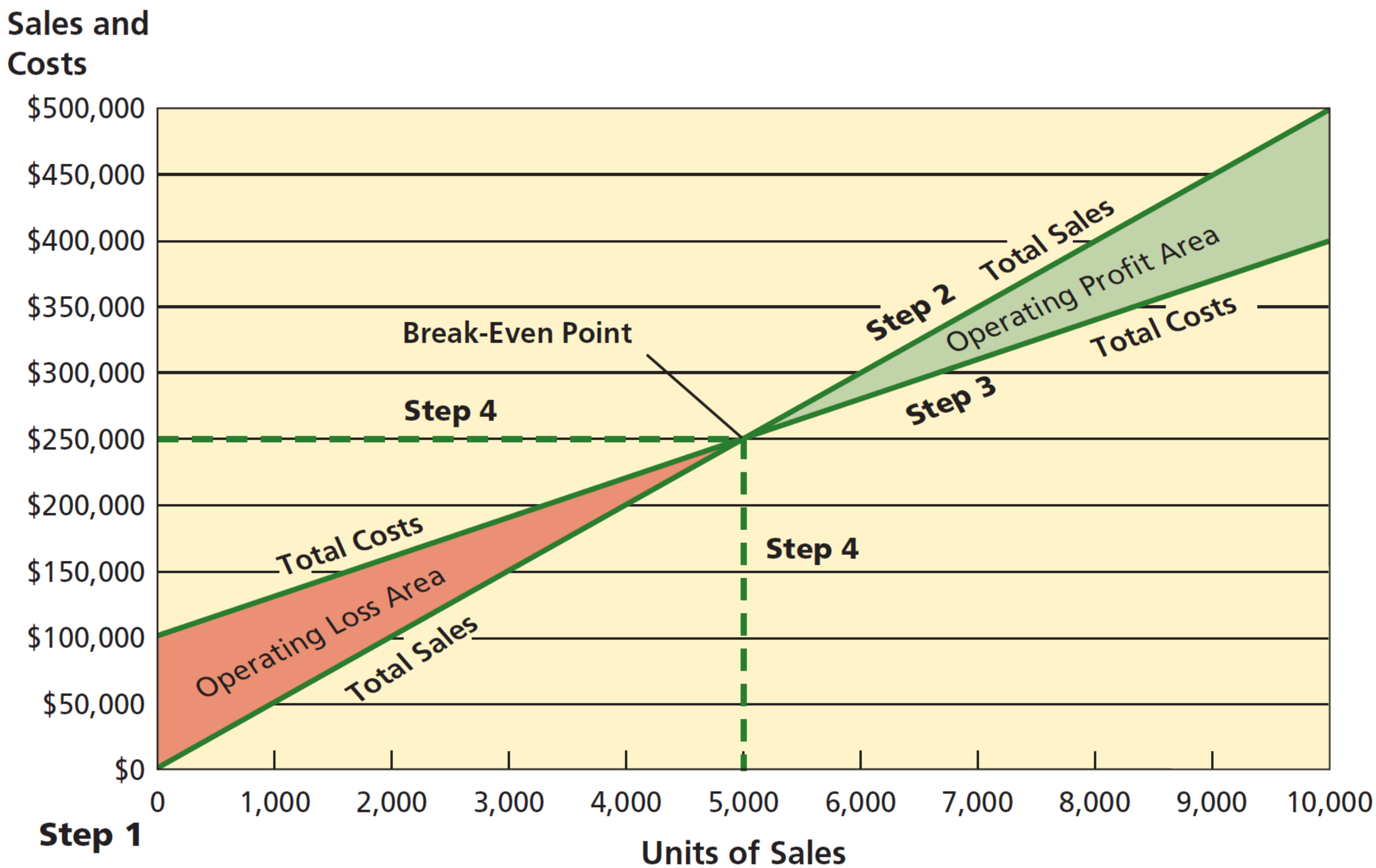
- The cost-volume-profit chart is constructed using the following steps:
  - Step 1. Volume in units of sales is indicated along the horizontal axis. The range of volume shown is the relevant range in which the company expects to operate. Dollar amounts of total sales and total costs are indicated along the vertical axis.
  - Step 2. A total sales line is plotted by connecting the point at zero on the left corner of the graph to a second point on the chart. The second point is determined by multiplying the maximum number of units in the relevant range, which is found on the far right of the horizontal axis, by the unit sales price. A line is then drawn through both of these points. This is the total sales line.
  - Step 3. A total cost line is plotted by beginning with total fixed costs on the vertical axis. A second point is determined by multiplying the maximum number of units in the relevant range, which is found on the far right of the horizontal axis by the unit variable costs and adding the total fixed costs. A line is then drawn through both of these points. This is the total cost line.
  - Step 4. The break-even point is the intersection point of the total sales and total cost lines. A vertical dotted line drawn downward at the intersection point indicates the units of sales at the break-even point. A horizontal dotted line drawn to the left at the intersection point indicates the sales dollars and costs at the break-even point.

Cost-Volume-Profit (Break-Even) Chart
(slide 3 of 5)

- Assume the following data for Munoz Co.:

Total fixed costs	$100,000
Unit selling price	$50
Unit variable cost	30
Unit contribution margin	$20

Cost-Volume-Profit Chart



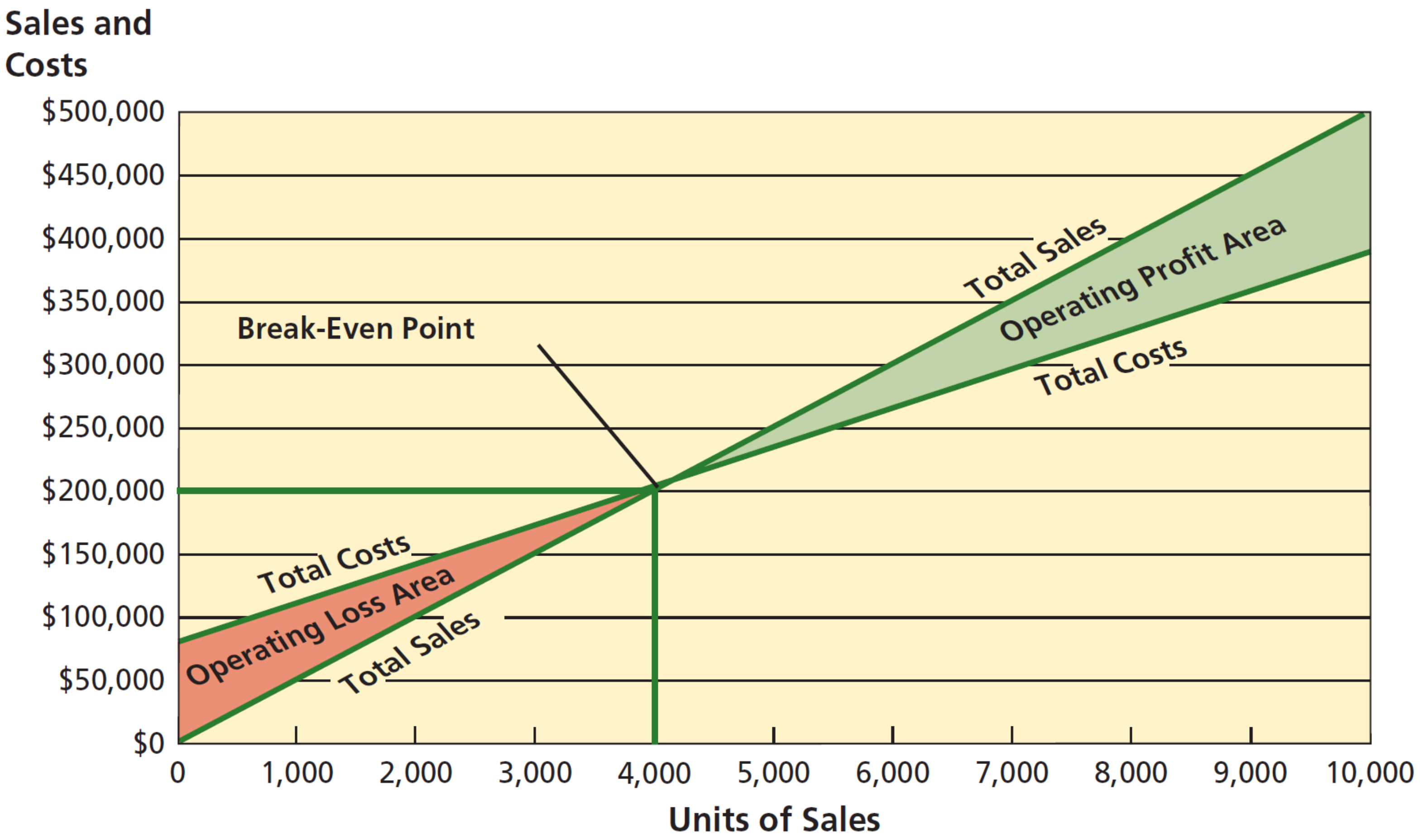
Cost-Volume-Profit (Break-Even) Chart
(slide 4 of 5)

- The break-even point for Munoz is $250,000 of sales, which represents sales of 5,000 units.
  - Operating profits will be earned when sales levels are to the right of the break-even point (operating profit area).
  - Operating losses will be incurred when sales levels are to the left of the break-even point (operating loss area).

Cost-Volume-Profit (Break-Even) Chart
(slide 5 of 5)

- Assume that Munoz is evaluating a proposal to reduce fixed costs by $20,000. In this case, the total fixed costs would be $80,000 ($100,000 – $20,000).
  - Under this scenario, the total sales line on the cost-volume-profit will not change, but the total cost line will change.
  - Also, the break-even point for Munoz will decrease to $200,000 and 4,000 units of sales.

Revised Cost-Volume-Profit Chart



Profit-Volume Chart
(slide 1 of 6)

- Another graphic approach to cost-volume-profit analysis is the **profit-volume chart**, which plots only the difference between total sales and total costs (or profits).
  - In this way, the profit-volume chart allows managers to determine the operating profit (or loss) for various levels of units sold.

Profit-Volume Chart
(slide 2 of 6)

- The profit-volume chart is constructed using the following steps:
  - Step 1. Volume in units of sales is indicated along the horizontal axis. The range of volume shown is the relevant range in which the company expects to operate. Dollar amounts indicating operating profits and losses are shown along the vertical axis.
  - Step 2. A point representing the maximum operating loss is plotted on the vertical axis at the left. This loss is equal to the total fixed costs at the zero level of sales.
  - Step 3. A point representing the maximum operating profit within the relevant range is plotted on the right.
  - Step 4. A diagonal profit line is drawn connecting the maximum operating loss point with the maximum operating profit point.
  - Step 5. The profit line intersects the horizontal zero operating profit line at the break-even point in units of sales. The area indicating an operating profit is identified to the right of the intersection, and the area indicating an operating loss is identified to the left of the intersection.

Profit-Volume Chart
(slide 3 of 6)

- Assume the following data for Munoz Co.:

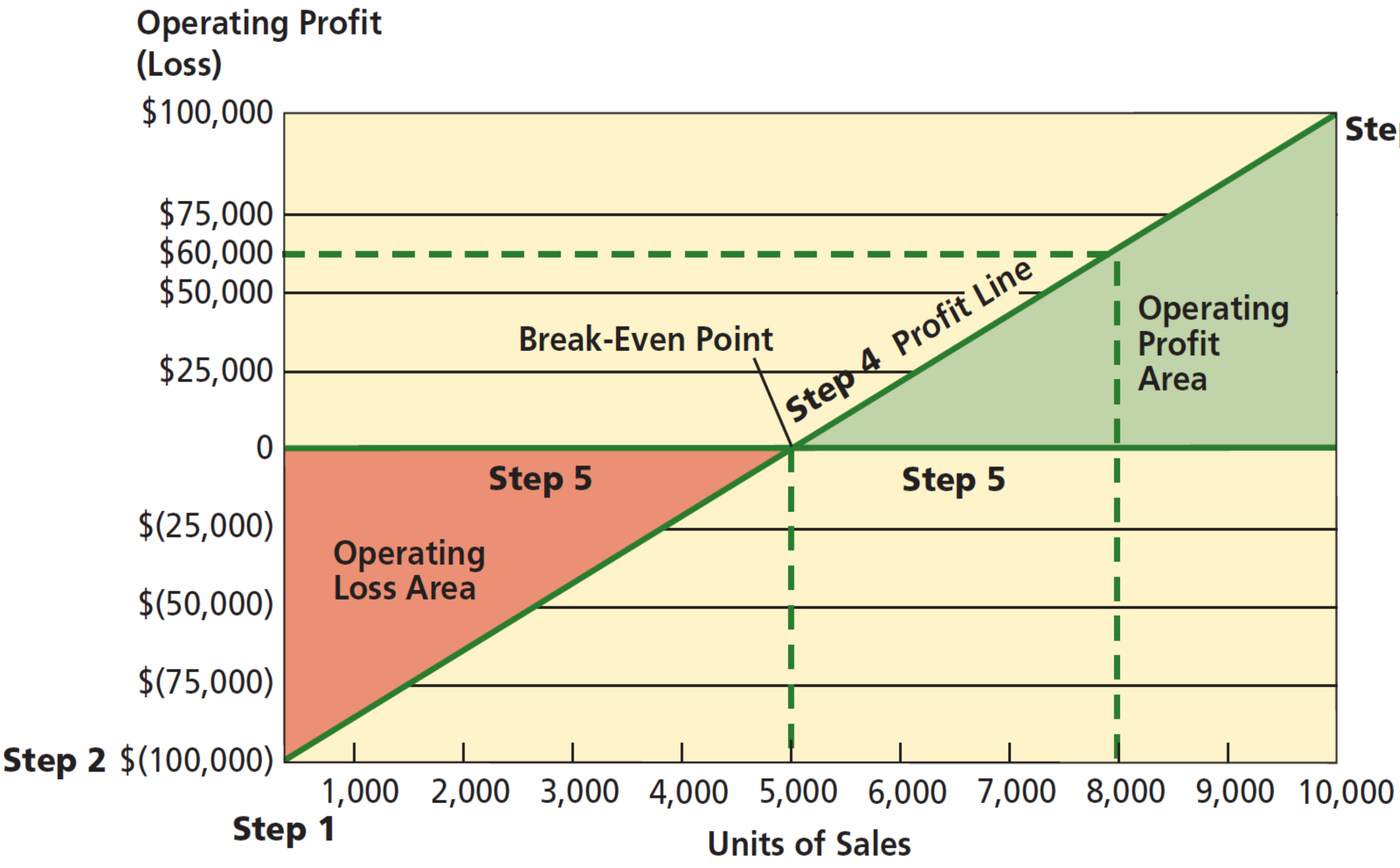
Total fixed costs	$100,000
Unit selling price	$50
Unit variable cost	30
Unit contribution margin	$20

Profit-Volume Chart
(slide 4 of 6)

- The maximum operating loss is equal to the fixed costs of $100,000. Assuming that the maximum units that can be sold within the relevant range is 10,000 units, the maximum operating profit is $100,000, computed as follows:

Sales (10,000 units × $50)	$500,000	
Variable costs (10,000 units × $30)	300,000	
Contribution margin (10,000 units × $20)	$200,000	
Fixed costs	100,000	
Operating profit	$100,000	← Maximum profit

Profit-Volume Chart



Profit-Volume Chart
(slide 5 of 6)

- The break-even point for Munoz is 5,000 units of sales, which is equal to total sales of $250,000.
  - Operating profits will be earned when sales levels are to the right of the break-even point (operating profit area).
  - Operating losses will be incurred when sales levels are to the left of the break-even point (operating loss area).

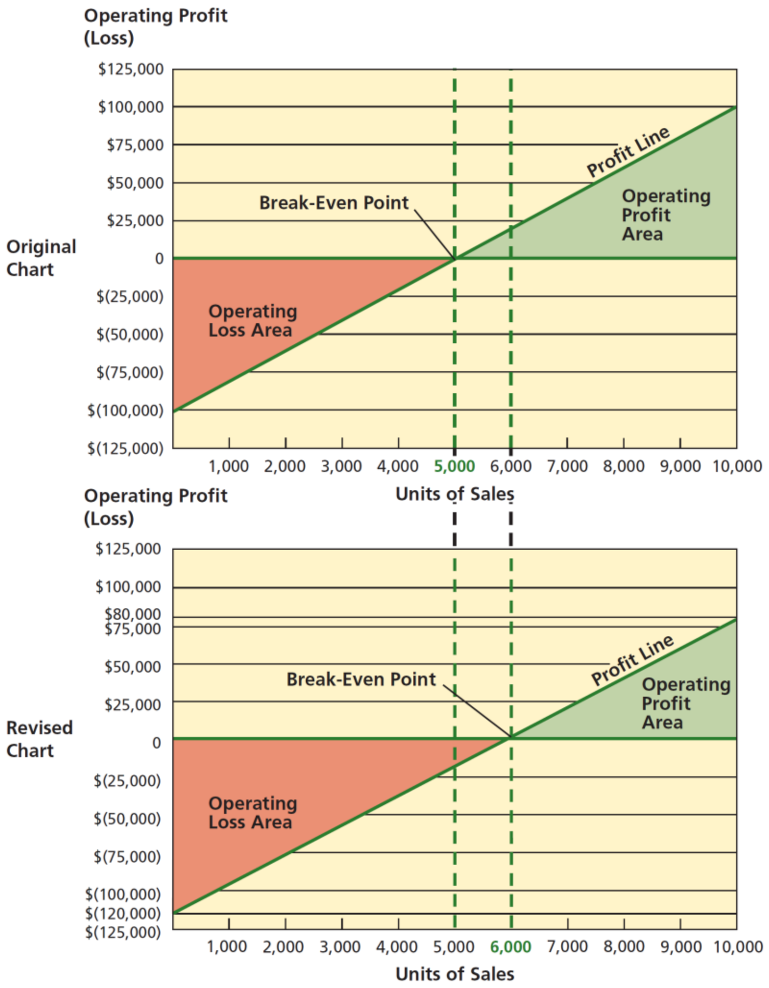
Profit-Volume Chart
(slide 6 of 6)

- Assume that Munoz is evaluating a proposal to increase fixed costs by $20,000. In this case, the total fixed costs will increase to $120,000 ($100,000 + $20,000), and the maximum operating loss will also increase to $120,000. At the maximum sales of 10,000 units, the maximum operating profit would be computed as follows:

Sales (10,000 units × $50)	$500,000	
Variable costs (10,000 units × $30)	300,000	
Contribution margin (10,000 units × $20)	$200,000	
Fixed costs	120,000	
Operating profit	$ 80,000	← Revised maximum profit

  - Under this scenario, the break-even point for Munoz will increase to $300,000 and 6,000 units of sales.
  - The operating loss area will increase, while the operating profit area will decrease.

Original Profit-Volume Chart and Revised Profit-Volume Chart



Assumptions of Cost-Volume-Profit Analysis

- Cost-volume-profit analysis depends on several assumptions. The primary assumptions are as follows:
  - Total sales and total costs can be represented by straight lines.
  - Within the relevant range of operating activity, the efficiency of operations does not change.
  - Costs can be divided into fixed and variable components.
  - The sales mix is constant.
  - There is no change in the inventory quantities during the period.

Sales Mix Considerations

- Many companies sell more than one product at different selling prices. In addition, the products normally have different unit variable costs and, thus, different unit contribution margins.
- In such cases, break-even analysis can still be performed by considering the sales mix.
    - The **sales mix** is the relative distribution of sales among the products sold by a company.

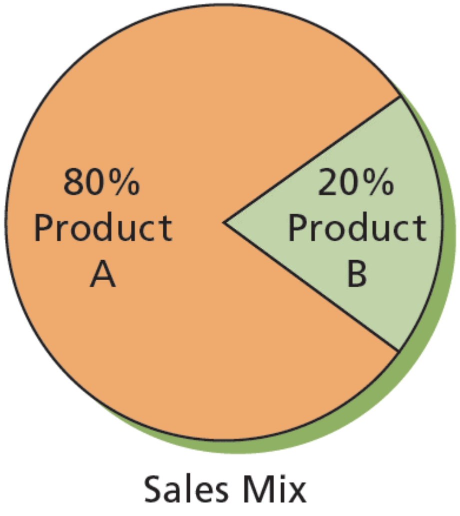
Sales Mix Considerations
(slide 2 of 5)

- Assume that Cascade Company sold Products A and B during the past year, as follows:

Total fixed costs	$200,000	
	Product A	**Product B**
Unit selling price	$90	$140
Unit variable cost	70	95
Unit contribution margin	$20	$ 45
Units sold	8,000	2,000
Sales mix	80%	20%

- A total of 10,000 (8,000 + 2,000) units were sold during the year. Therefore, the sales mix is 80% (8,000 ÷ 10,000) for Product A and 20% (2,000 ÷ 10,000) for Product B.

Multiple Product Sales Mix



Sales Mix Considerations
(slide 3 of 5)

- For break-even analysis, it is useful to think of the individual products as components of one overall enterprise product.
- The unit selling price of the overall enterprise product equals the sum of the unit selling prices of each product multiplied by its sales mix percentage.
- Likewise, the unit variable cost and unit contribution margin of the overall enterprise product equal the sum of the unit variable costs and unit contribution margins of each product multiplied by its sales mix percentage.

Sales Mix Considerations
(slide 4 of 5)

- For Cascade, Products A and B are components of one overall enterprise product called E. The unit selling price, unit variable cost, and unit contribution margin for E are computed as follows:

Product E			Product A		Product B
Unit selling price of E	\$100	=	(\$90 × 0.8)	+	(\$140 × 0.2)
Unit variable cost of E	75	=	(\$70 × 0.8)	+	(\$95 × 0.2)
Unit contribution margin of E	\$ 25	=	(\$20 × 0.8)	+	(\$45 × 0.2)

Sales Mix Considerations
(slide 5 of 5)

- Cascade has total fixed costs of $200,000. The break-even point of E can be determined as follows using the unit selling price, unit variable cost, and unit contribution margin of E:

$$\text{Break-Even Sales (units) for E} = \frac{\text{Fixed Costs}}{\text{Unit Contribution Margin}} = \frac{\$200{,}000}{\$25} = 8{,}000 \text{ units}$$

- Because the sales mix for Products A and B is 80% and 20% respectively, the break-even quantity of A is 6,400 units (8,000 units × 80%) and B is 1,600 units (8,000 units × 20%).

Break-Even Sales: Multiple Products

	Product A	Product B	Total
Sales:			
6,400 units × $90	$576,000		$576,000
1,600 units × $140		$224,000	224,000
Total sales	$576,000	$224,000	$800,000
Variable costs:			
6,400 units × $70	$448,000		$448,000
1,600 units × $95		$152,000	152,000
Total variable costs	$448,000	$152,000	$600,000
Contribution margin	$128,000	$ 72,000	$200,000
Fixed costs			200,000
Income from operations			$ 0

Break-even point

Example Exercise

Megan Company has fixed costs of $180,000. The unit selling price, variable cost per unit, and contribution margin per unit for the company's two products are as follows:

Product	Selling Price	Variable Cost per Unit	Contribution Margin per Unit
Q	$160	$100	$60
Z	100	80	20

The sales mix for products Q and Z is 75% and 25%, respectively. Determine the break-even point in units of Q and Z.

Example Exercise

Sales Mix and Break-Even Analysis (slide 2 of 2)

Unit selling price of E:	[($160 × 0.75) + ($100 × 0.25)] =	$145
Unit variable cost of E:	[($100 × 0.75) + ($80 × 0.25)] =	95
Unit contribution margin of E:		$ 50

Break-Even Sales (units) for E = $180,000 ÷ $50 = 3,600 units

Break-Even Sales (units) for Q = 3,600 units of E × 75% = 2,700 units of Product Q

Break-Even Sales (units) for Z = 3,600 units of E × 25% = 900 units of Product Z

Operating Leverage
(slide 1 of 5)

- The relationship between a company's contribution margin and income from operations is measured by **operating leverage**.
- A company's operating leverage is computed as follows:

$$\text{Operating Leverage} = \frac{\text{Contribution Margin}}{\text{Income from Operations}}$$

  - The difference between contribution margin and income from operations is fixed costs.
    - Thus, companies with high fixed costs will normally have high operating leverage.

Operating Leverage
(slide 2 of 5)

- Assume the following data for Jones Inc. and Wilson Inc.:

	Jones Inc.	Wilson Inc.
Sales	$400,000	$400,000
Variable costs	300,000	300,000
Contribution margin	$100,000	$100,000
Fixed costs	80,000	50,000
Income from operations	$ 20,000	$ 50,000

- As shown, Jones and Wilson have the same sales, the same variable costs, and the same contribution margin. However, Jones has larger fixed costs and, thus, a higher operating leverage than Wilson.

Jones Inc.

$$\text{Operating Leverage} = \frac{\text{Contribution Margin}}{\text{Income from Operations}} = \frac{\$100,000}{\$20,000} = 5$$

Wilson Inc.

$$\text{Operating Leverage} = \frac{\text{Contribution Margin}}{\text{Income from Operations}} = \frac{\$100,000}{\$50,000} = 2$$

Operating Leverage
(slide 3 of 5)

- Operating leverage can be used to measure the impact of changes in sales on income from operations.
- Using operating leverage, the effect of changes in sales on income from operations follows:

$$\text{Percent Change in Income from Operations} = \text{Percent Change in Sales} \times \text{Operating Leverage}$$

Operating Leverage
(slide 4 of 5)

- Assume that sales increased by 10%, or $40,000 ($400,000 × 10%), for Jones and Wilson. The percent increase in income from operations for Jones and Wilson is computed as follo

Jones Inc.

$$\text{Percent Change in Income from Operations} = \text{Percent Change in Sales} \times \text{Operating Leverage}$$

$$= 10\% \times 5 = 50\%$$

Wilson Inc.

$$\text{Percent Change in Income from Operations} = \text{Percent Change in Sales} \times \text{Operating Leverage}$$

$$= 10\% \times 2 = 20\%$$

Operating Leverage
(slide 5 of 5)

- The validity of this analysis is shown in the following income statements for Jones and Wilson based on the 10% increase in sales:

	Jones Inc.	Wilson Inc.
Sales	$440,000	$440,000
Variable costs	330,000	330,000
Contribution margin	$110,000	$110,000
Fixed costs	80,000	50,000
Income from operations	$ 30,000	$ 60,000

Effect of Operating Leverage on Income from Operations

Operating Leverage	Percentage Impact on Income from Operations from a Change in Sales
High	Large
Low	Small

Example Exercise

Operating Leverage

Tucker Company reports the following data:

Sales	$750,000
Variable costs	500,000
Contribution margin	$250,000
Fixed costs	187,500
Income from operations	$ 62,500

Determine Tucker Company's operating leverage.

$$\text{Operating Leverage} = \frac{\text{Contribution Margin}}{\text{Income from Operations}} = \frac{\$250{,}000}{\$62{,}500} = 4.0$$

Margin of Safety
(slide 1 of 3)

- The **margin of safety** indicates the possible decrease in sales that may occur before an operating loss results.
  - Thus, if the margin of safety is low, even a small decline in sales revenue may result in an operating loss.

Margin of Safety
(slide 2 of 3)

- The margin of safety may be expressed in the following ways:
  - Dollars of sales
    - The margin of safety expressed in dollars of sales is computed as follows:

$$\text{Margin of Safety} = \text{Sales} - \text{Sales at Break-Even Point}$$

  - Units of sales
    - The margin of safety expressed in units of sales is computed as follows:

$$\text{Margin of Safety} = \frac{\text{Sales} - \text{Sales at Break-Even Point}}{\text{Unit Selling Price}}$$

  - Percent of current sales
    - The margin of safety expressed as a percent of current sales is computed as follows:

$$\text{Margin of Safety} = \frac{\text{Sales} - \text{Sales at Break-Even Point}}{\text{Sales}}$$

Margin of Safety
(slide 3 of 3)

- Assume the following data:

Sales	$250,000
Sales at the break-even point	200,000
Unit selling price	25

- The margin of safety in dollars of sales is $50,000 ($250,000 – $200,000).
- The margin of safety in units is 2,000 units ($50,000 – $25).
- The margin of safety expressed as a percent of current sales is 20% ($50,000 ÷ $250,000).

Therefore, the current sales may decline $50,000, 2,000 units, or 20% before an operating loss occurs.

Example Exercise

Rachel Company has sales of $400,000, and the break-even point in sales dollars is $300,000. Determine the company's margin of safety as a percent of current sales.

$$\text{Margin of Safety} = \frac{\text{Sales} - \text{Sales at Break-Even Point}}{\text{Sales}} = \frac{\$400{,}000 - \$300{,}000}{\$400{,}000} = \frac{\$100{,}000}{\$400{,}000} = 25\%$$

Appendix: Variable Costing
(slide 1 of 6)

- The cost of manufactured products consists of direct materials, direct labor, and factory overhead. The reporting of all these costs in financial statements is called **absorption costing**.
  - Absorption costing is required under generally accepted accounting principles for financial statements distributed to external users.
    - However, alternative reports may be prepared for decision-making purposes by managers and other internal users.
      - One such alternative is variable costing or direct costing.

Appendix: Variable Costing
(slide 2 of 6)

- In variable costing, the cost of goods manufactured is composed only of variable costs. Thus, the cost of goods manufactured consists of direct materials, direct labor, and variable factory overhead.
- In a variable costing income statement, fixed factory overhead costs do not become a part of the cost of goods manufactured. Instead, fixed factory overhead costs are treated as a period expense.

Absorption Versus Variable Cost of Goods Manufactured

Cost of Goods Manufactured	
Absorption Costing	**Variable Costing**
Direct materials	Direct materials
Direct labor	Direct labor
Variable factory overhead	Variable factory overhead
Fixed factory overhead	

Appendix: Variable Costing
(slide 3 of 6)

- The form of a variable costing income statement is as follows:

Sales		$XXX
Variable cost of goods sold		XXX
Manufacturing margin		$XXX
Variable selling and administrative expenses		XXX
Contribution margin		$XXX
Fixed costs:		
Fixed manufacturing costs	$XXX	
Fixed selling and administrative expenses	XXX	XXX
Income from operations		$XXX

Appendix: Variable Costing
(slide 4 of 6)

- Assume that Martinez Co. manufactures 15,000 units, which are sold at a price of $50. The related costs and expenses for Martinez are as f

	Total Cost	Number of Units	Unit Cost
Manufacturing costs:			
Variable	$375,000	15,000	$25
Fixed	150,000	15,000	10
Total	$525,000		$35
Selling and administrative expenses:			
Variable ($5 per unit sold)	$ 75,000		
Fixed	50,000		
Total	$125,000		

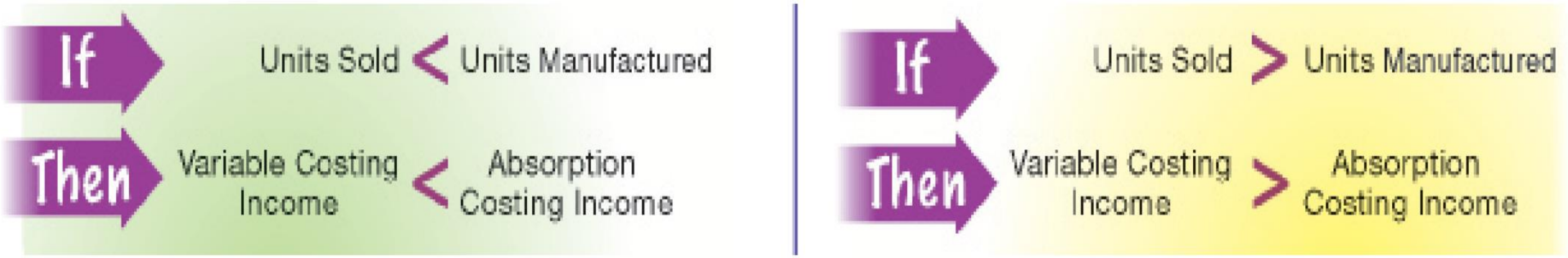
Variable Costing Income Statement

Sales (15,000 × $50)		$750,000
Variable cost of goods sold (15,000 × $25)		375,000
Manufacturing margin		$375,000
Variable selling and administrative expenses (15,000 × $5)		75,000
Contribution margin		$300,000
Fixed costs:		
Fixed manufacturing costs	$150,000	
Fixed selling and administrative expenses	50,000	200,000
Income from operations		$100,000

Absorption Costing Income Statement

Sales (15,000 × $50)	$750,000
Cost of goods sold (15,000 × $35)	525,000
Gross profit	$225,000
Selling and administrative expenses ($75,000 + $50,000)	125,000
Income from operations	$100,000

Relationship Between Variable and Absorption Costing Income



Appendix: Variable Costing
(slide 5 of 6)

- Assume that only 12,000 units of the 15,000 units Martinez manufactured were sold.

Units Manufactured Exceed Units Sold

Variable Costing Income Statement

Sales (12,000 × $50)		$600,000
Variable cost of goods sold:		
Variable cost of goods manufactured (15,000 × $25)	$375,000	
Less ending inventory (3,000 × $25)	75,000	
Variable cost of goods sold		300,000
Manufacturing margin		$300,000
Variable selling and administrative expenses (12,000 × $5)		60,000
Contribution margin		$240,000
Fixed costs:		
Fixed manufacturing costs	$150,000	
Fixed selling and administrative expenses	50,000	200,000
Income from operations		$ 40,000

Absorption Costing Income Statement

Sales (12,000 × $50)		$600,000
Cost of goods sold:		
Cost of goods manufactured (15,000 × $35)	$525,000	
Less ending inventory (3,000 × $35)	105,000	
Cost of goods sold		420,000
Gross profit		$180,000
Selling and administrative expenses [(12,000 × $5) + $50,000]		110,000
Income from operations		$ 70,000

Appendix: Variable Costing
(slide 6 of 6)

- The $30,000 difference in income from operations is due to the fixed manufacturing costs.
  - All of the $150,000 of fixed manufacturing costs is included as a period expense in the variable costing statement.
  - However, the 3,000 units of ending inventory in the absorption costing statement include $30,000 (3,000 × $10) of fixed manufacturing costs. By being included in inventory, this $30,000 is thus excluded from the current cost of goods sold.
    - Thus, the absorption costing income from operations is $30,000 higher than the income from operations for variable costing.