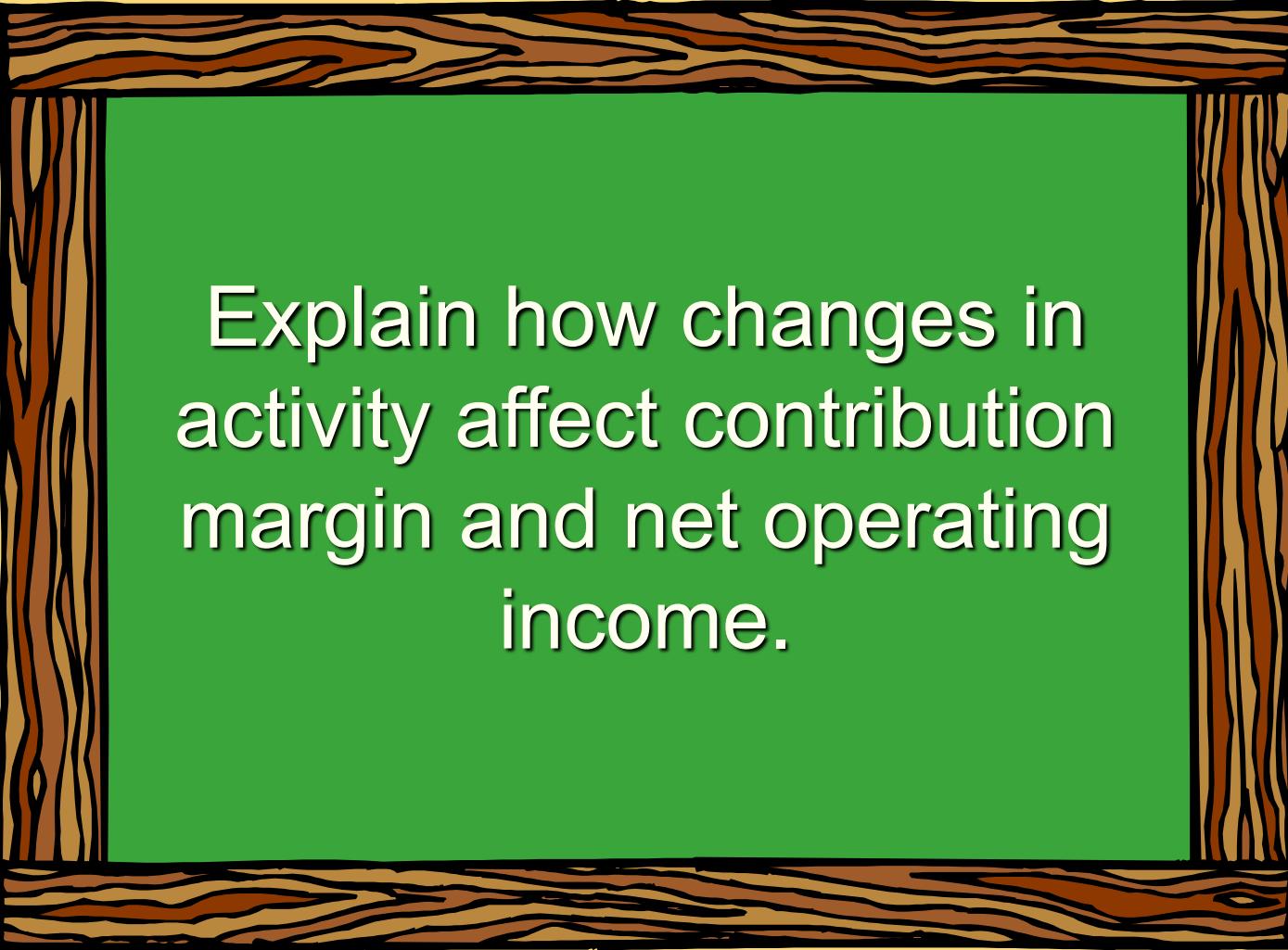


Cost-Volume-Profit Relationships

Lecture-6



Learning Objective 1



Explain how changes in activity affect contribution margin and net operating income.

Basics of Cost-Volume-Profit Analysis



The screenshot shows a Microsoft Excel spreadsheet with a title bar, menu bar, and toolbar. The active cell is H10. The spreadsheet contains a contribution income statement for the month of June, starting from row 5. The statement includes sales, variable expenses, contribution margin, fixed expenses, and net income. The net income is highlighted with a yellow background.

Racing Bicycle Company Contribution Income Statement For the Month of June					
5	Sales (500 bicycles)	\$ 250,000			
6	Less: Variables expenses	150,000			
7	Contribution margin	100,000			
8	Less: Fixed expenses	80,000			
9	Net income	\$ 20,000			

Contribution Margin (CM) is the amount remaining from sales revenue after variable expenses have been deducted.

Basics of Cost-Volume-Profit Analysis



The screenshot shows a Microsoft Excel spreadsheet with a title bar, menu bar, and toolbar. The spreadsheet contains a contribution income statement for the month of June. The statement is presented in a table format with a light green background and a black border. The data includes sales, variable expenses, contribution margin, fixed expenses, and net income.

Racing Bicycle Company Contribution Income Statement For the Month of June					
5	Sales (500 bicycles)	\$ 250,000			
6	Less: Variables expenses	150,000			
7	Contribution margin	100,000			
8	Less: Fixed expenses	80,000			
9	Net income	\$ 20,000			

CM is used first to cover fixed expenses. Any remaining CM contributes to net operating income.

The Contribution Approach

Sales, variable expenses, and contribution margin can also be expressed on a per unit basis. If Racing sells an additional bicycle, \$200 additional CM will be generated to cover fixed expenses and profit.

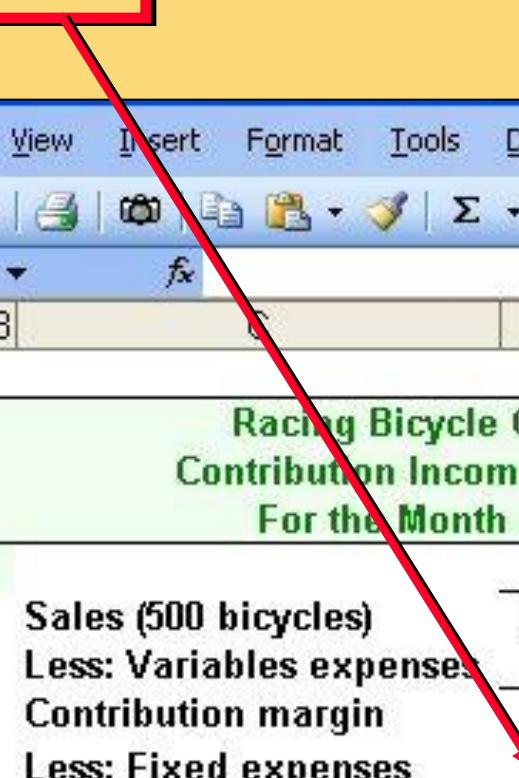


A red arrow originates from the circled '\$200' in the text above and points directly to the 'Per Unit' column header in the table below.

Racing Bicycle Company Contribution Income Statement For the Month of June		
	Total	Per Unit
Sales (500 bicycles)	\$ 250,000	\$ 500
Less: Variables expenses	150,000	300
Contribution margin	100,000	<u>\$ 200</u>
Less: Fixed expenses	80,000	
Net income	<u>\$ 20,000</u>	

The Contribution Approach

Each month, Racing must generate at least
\$80,000 in total CM to break even.



Racing Bicycle Company Contribution Income Statement For the Month of June	
	Total Per Unit
Sales (500 bicycles)	\$ 250,000 \$ 500
Less: Variables expenses:	150,000 300
Contribution margin	<u>100,000</u> <u>\$ 200</u>
Less: Fixed expenses	80,000
Net income	<u><u>\$ 20,000</u></u>

The Contribution Approach

If Racing sells 400 units in a month, it will be operating at the *break-even point*.



		Racing Bicycle Company Contribution Income Statement For the Month of June					
				Total	Per Unit		
1		Sales (400 bicycles)		\$ 200,000		\$ 500	
2		Less: Variables expenses		120,000		300	
3		Contribution margin		80,000		\$ 200	
4		Less: Fixed expenses		80,000			
5		Net income		\$ -			

The Contribution Approach



If Racing sells one more bike (**401 bikes**), net operating income will increase by **\$200**.

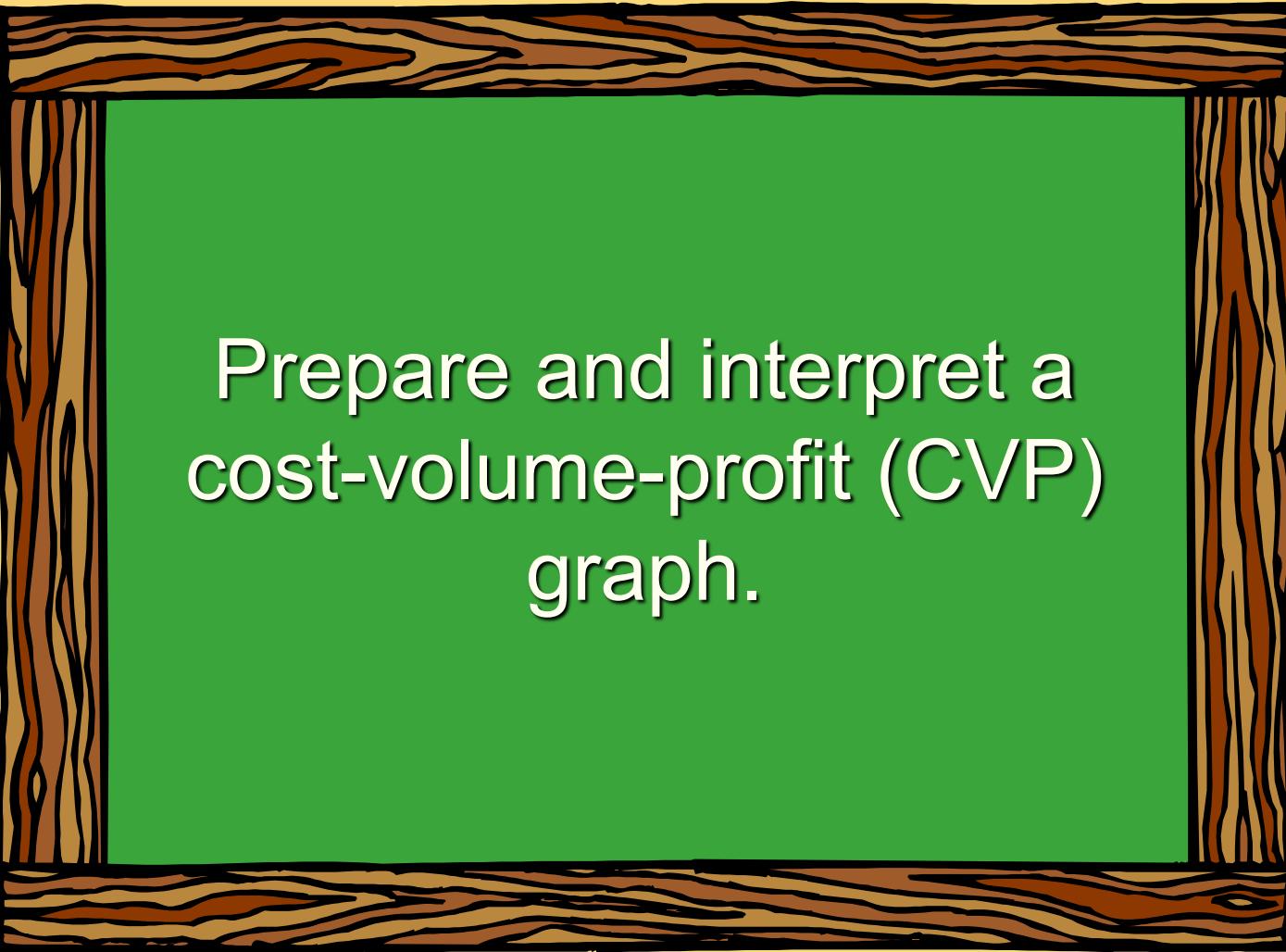
A red arrow points from the text "Sales (401 bicycles)" in the statement to the "Sales" line in the table. Another red arrow points from the text "net operating income will increase by \$200" to the "Net income" line in the table.

Racing Bicycle Company Contribution Income Statement For the Month of June		
	Total	Per Unit
Sales (401 bicycles)	\$ 200,500	\$ 500
Less: Variables expenses	120,300	300
Contribution margin	80,200	200
Less: Fixed expenses	80,000	
Net income	\$ 200	

The Contribution Approach

We do not need to prepare an income statement to estimate profits at a particular sales volume. Simply multiply the number of units sold above break-even by the contribution margin per unit.

Learning Objective 2



Prepare and interpret a
cost-volume-profit (CVP)
graph.

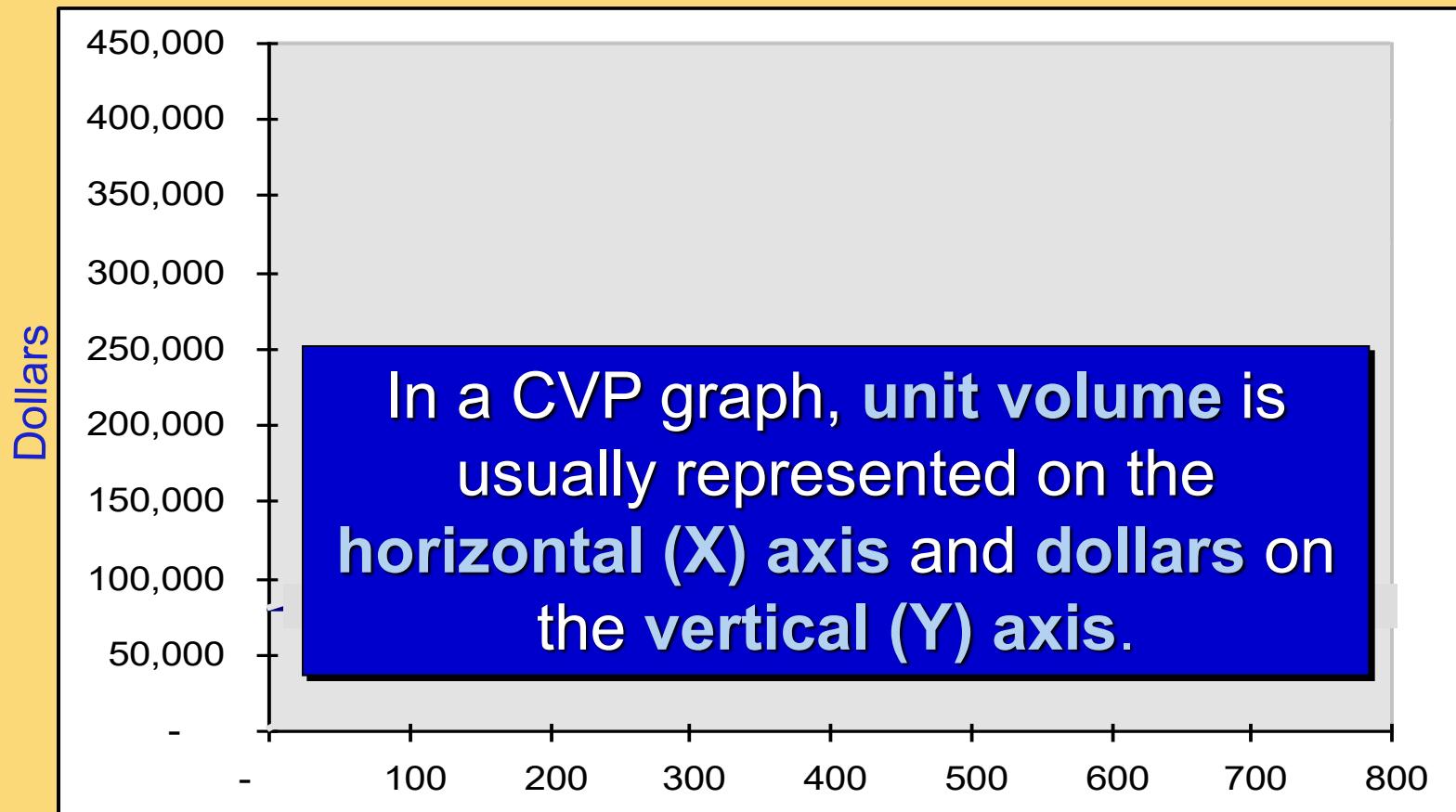
CVP Relationships in Graphic Form



The relationship among revenue, cost, profit and volume can be expressed graphically by preparing a CVP graph. Racing developed contribution margin income statements at 300, 400, and 500 units sold. We will use this information to prepare the CVP graph.

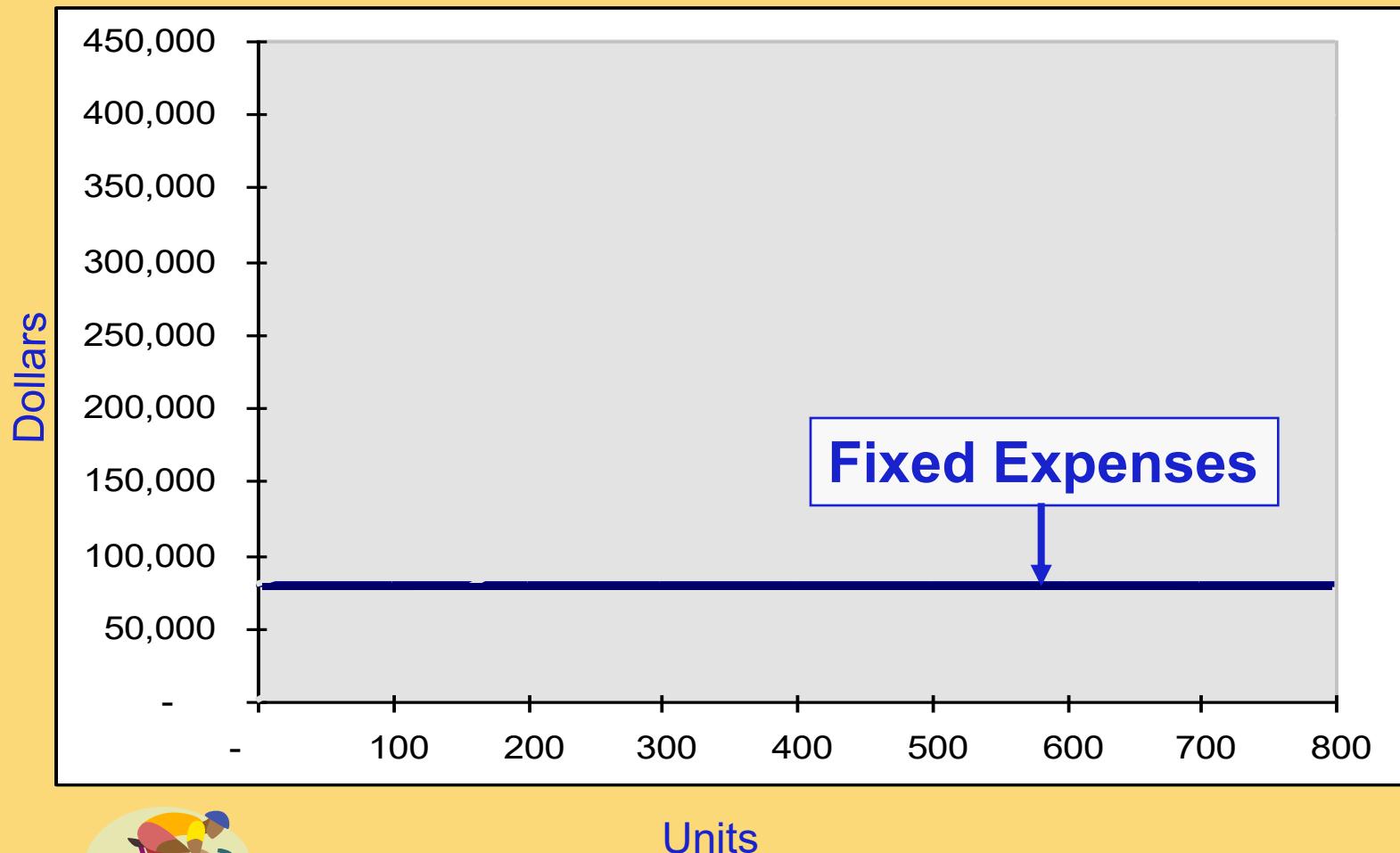
	Income 300 units	Income 400 units	Income 500 units
Sales	\$ 150,000	\$ 200,000	\$ 250,000
Less: variable expenses	90,000	120,000	150,000
Contribution margin	\$ 60,000	\$ 80,000	\$ 100,000
Less: fixed expenses	80,000	80,000	80,000
Net operating income	\$ (20,000)	\$ -	\$ 20,000

CVP Graph

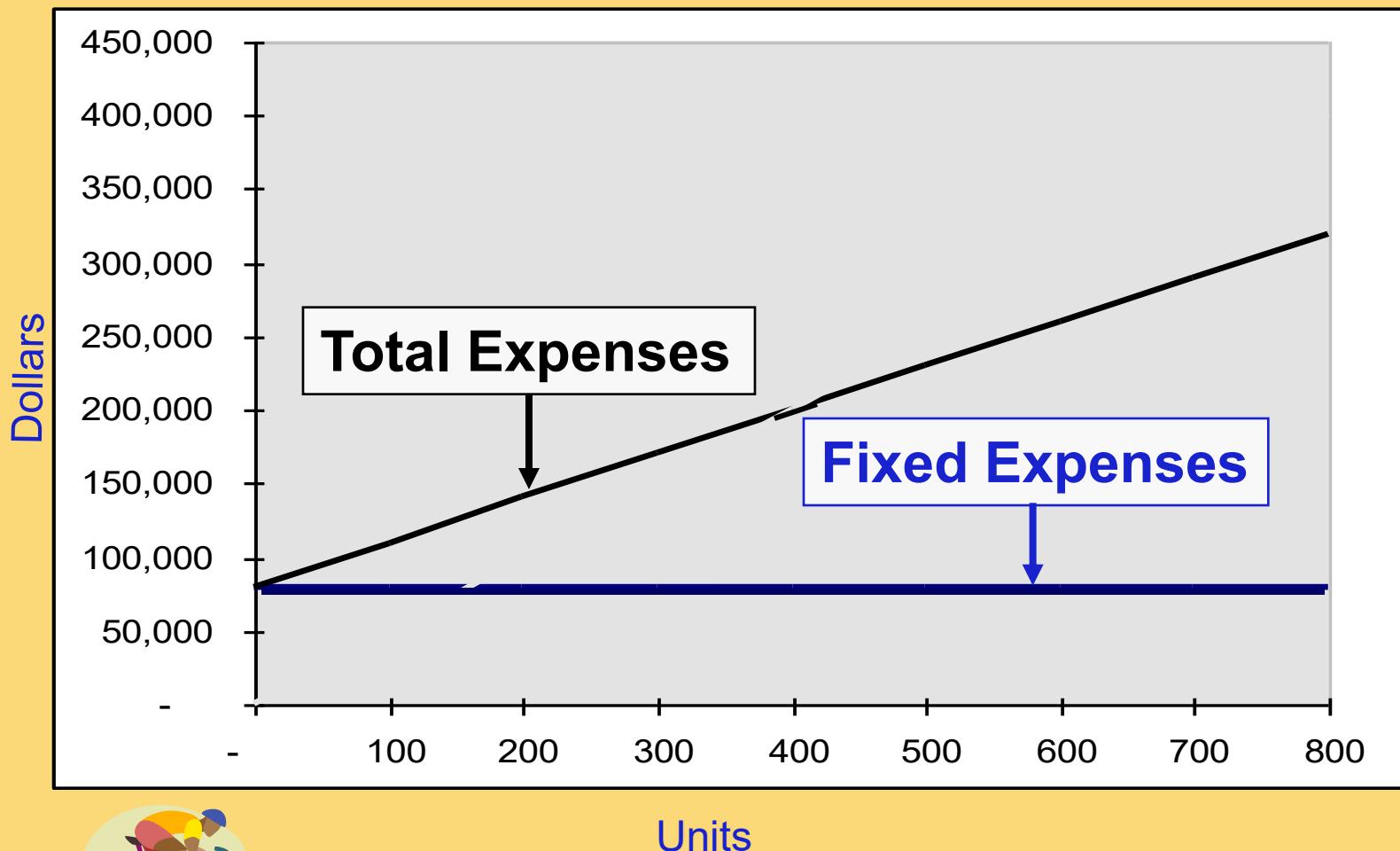


Units

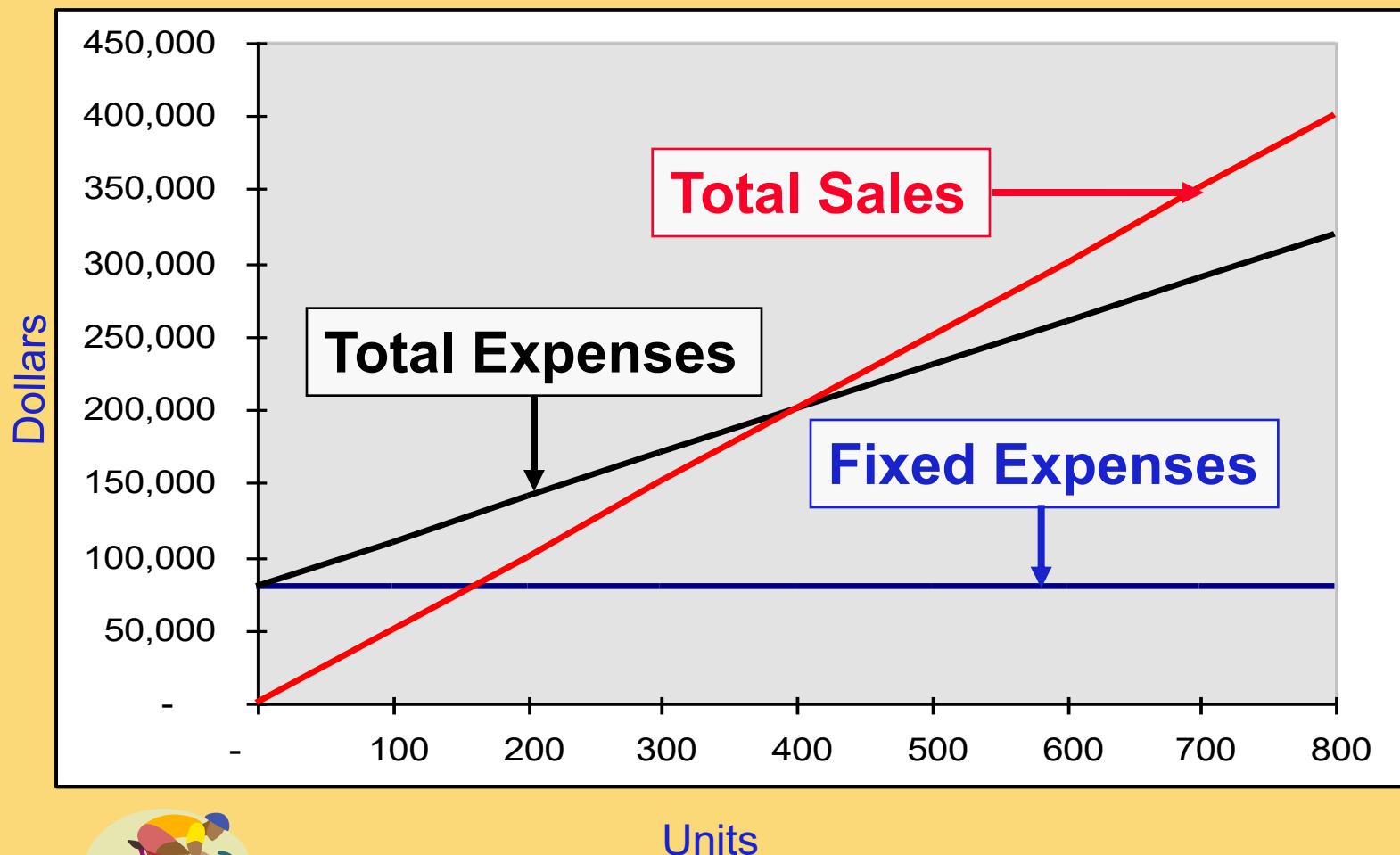
CVP Graph



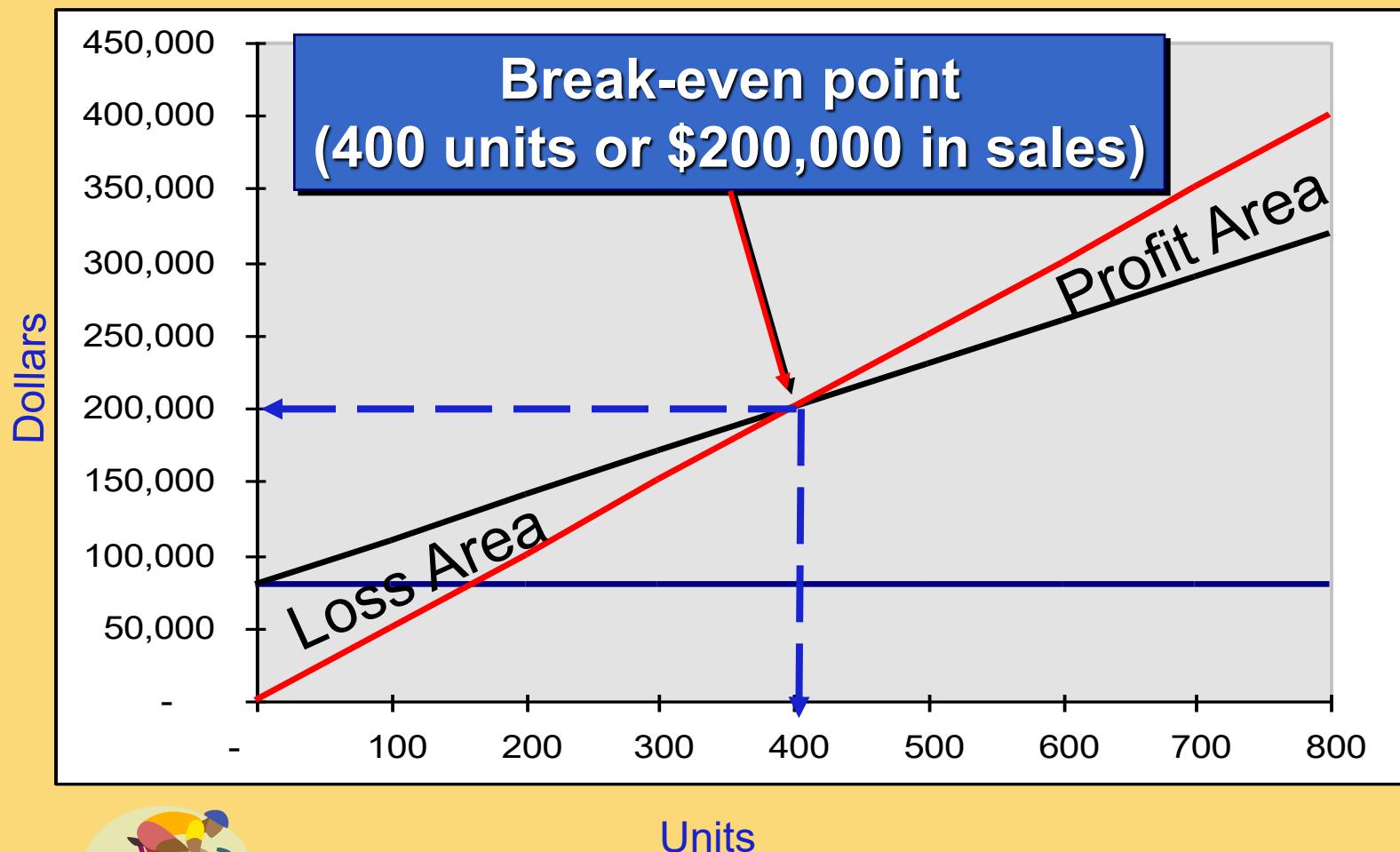
CVP Graph



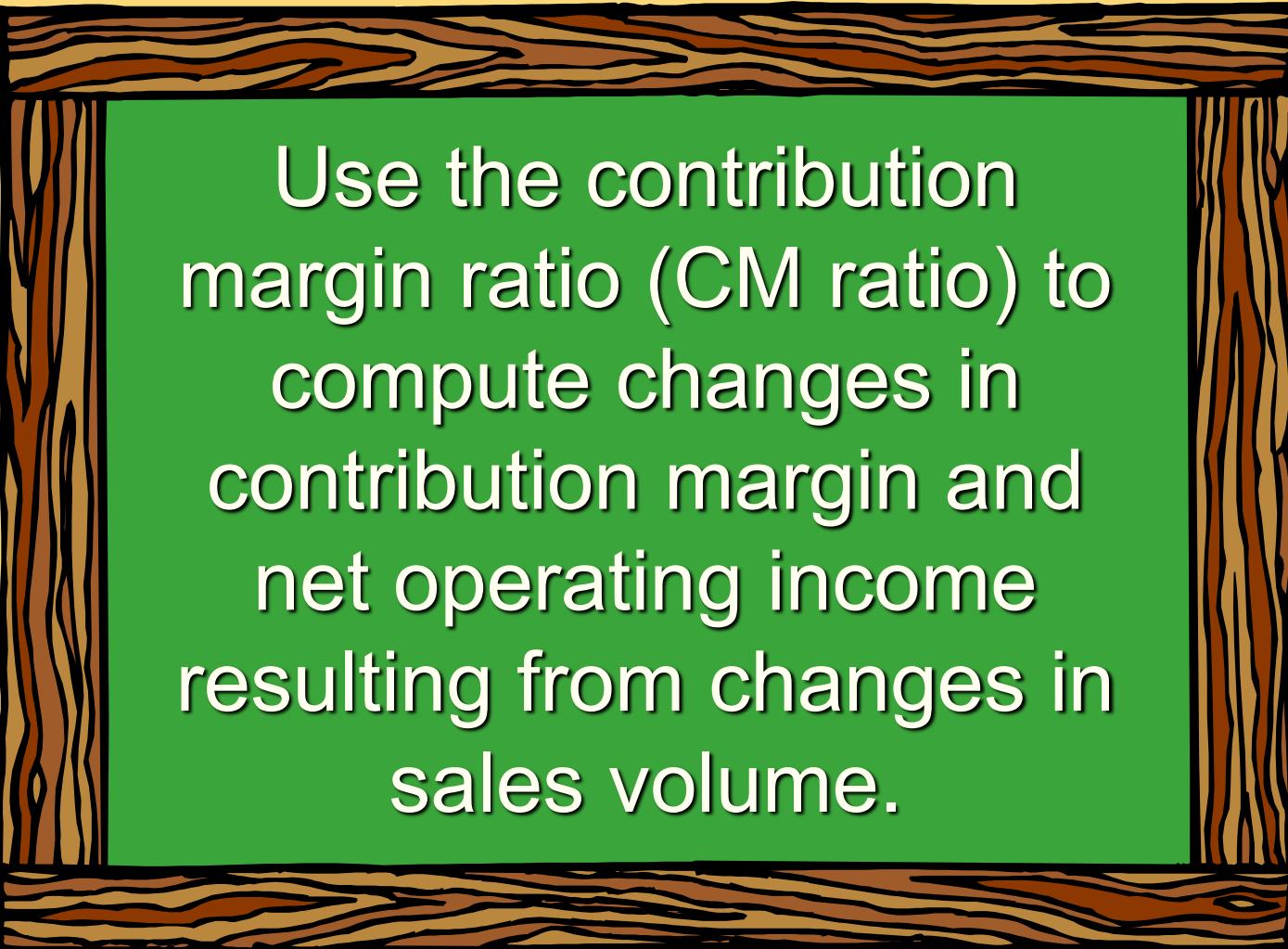
CVP Graph



CVP Graph



Learning Objective 3



Use the contribution margin ratio (CM ratio) to compute changes in contribution margin and net operating income resulting from changes in sales volume.

Contribution Margin Ratio

The contribution margin **ratio** is:

$$\text{CM Ratio} = \frac{\text{Total CM}}{\text{Total sales}}$$

For Racing Bicycle Company the ratio is:

$$\frac{\$80,000}{\$200,000} = 40\%$$

Each \$1.00 increase in sales results in a total contribution margin increase of 40¢.



Contribution Margin Ratio

Or, in terms of **units**, the contribution margin **ratio** is:

$$\text{CM Ratio} = \frac{\text{Unit CM}}{\text{Unit selling price}}$$

For Racing Bicycle Company the ratio is:

$$\frac{\$200}{\$500} = 40\%$$



Contribution Margin Ratio

	400 Bikes	500 Bikes
Sales	\$ 200,000	\$ 250,000
Less: variable expenses	120,000	150,000
Contribution margin	80,000	100,000
Less: fixed expenses	80,000	80,000
Net operating income	\$ -	\$ 20,000

A \$50,000 increase in sales revenue results in a \$20,000 increase in CM.
 $(\$50,000 \times 40\% = \$20,000)$

Quick Check ✓

Coffee Klatch is an espresso stand in a downtown office building. The average selling price of a cup of coffee is \$1.49 and the average variable expense per cup is \$0.36. The average fixed expense per month is \$1,300. 2,100 cups are sold each month on average. What is the CM Ratio for Coffee Klatch?

- a. 1.319
- b. 0.758
- c. 0.242
- d. 4.139

Quick Check ✓

Coffee Klatch is an espresso stand in a downtown office building. The average selling price of a cup of coffee is \$1.49 and the average variable expense per cup is \$0.36. The average fixed expense per month is \$1,300. 2,100 cups are sold each month on average. What is the CM Ratio for Coffee Klatch?

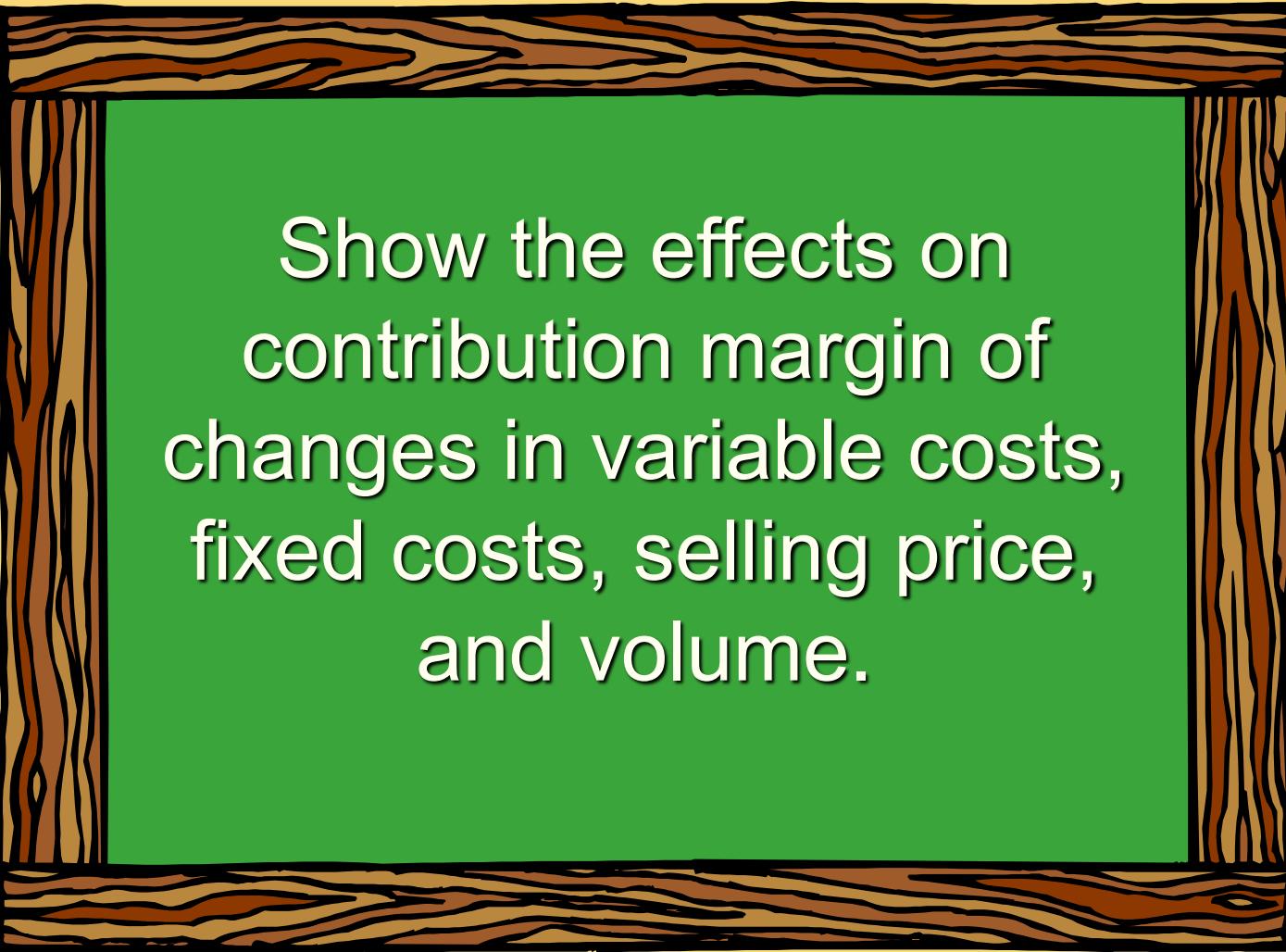
- a. 1.319
- b. 0.758**
- c. 0.242
- d. 4.139

$$\text{CM Ratio} = \frac{\text{Unit contribution margin}}{\text{Unit selling price}}$$

$$= \frac{(\$1.49 - \$0.36)}{\$1.49}$$

$$= \frac{\$1.13}{\$1.49} = 0.758$$

Learning Objective 4



Show the effects on contribution margin of changes in variable costs, fixed costs, selling price, and volume.

Changes in Fixed Costs and Sales Volume

What is the profit impact if Racing can increase unit sales from 500 to 540 by increasing the monthly advertising budget by \$10,000?



Changes in Fixed Costs and Sales Volume

\$80,000 + \$10,000 advertising = \$90,000



		Racing Bicycle Company Contribution Income Statement For the Month of June	
		Current Sales (500 bikes)	Projected Sales (540 bikes)
Sales revenue		\$ 250,000	\$ 270,000
Less: Variables expenses		150,000	162,000
Contribution margin		100,000	108,000
Less: Fixed expenses		80,000	90,000
Net income		\$ 20,000	\$ 18,000

Sales **increased** by \$20,000, but net operating income **decreased** by \$2,000.

Changes in Fixed Costs and Sales Volume

The Shortcut Solution

Increase in CM (40 units X \$200)	\$ 8,000
Increase in advertising expenses	10,000
Decrease in net operating income	<u><u>\$ (2,000)</u></u>



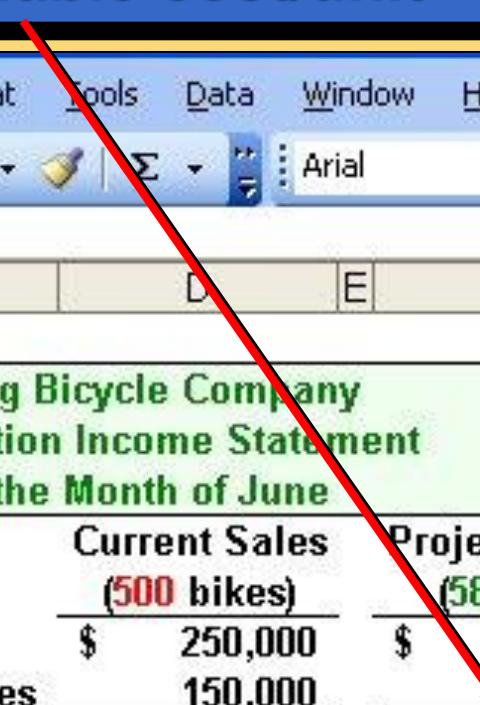
Change in Variable Costs and Sales Volume

What is the profit impact if Racing can use higher quality raw materials, thus increasing variable costs per unit by \$10, to generate an increase in unit sales from 500 to 580?



Change in Variable Costs and Sales Volume

580 units × \$310 variable cost/unit = \$179,800



Racing Bicycle Company Contribution Income Statement For the Month of June		
	Current Sales <u>(500 bikes)</u>	Projected Sales <u>(580 bikes)</u>
Sales revenue	\$ 250,000	\$ 290,000
Less: Variables expenses	150,000	179,800
Contribution margin	100,000	110,200
Less: Fixed expenses	80,000	80,000
Net income	\$ 20,000	\$ 30,200

**Sales *increase* by \$40,000, and net operating income
increases by \$10,200.**

Change in Fixed Cost, Sales Price and Volume

What is the profit impact if Racing (1) cuts its selling price \$20 per unit, (2) increases its advertising budget by \$15,000 per month, and (3) increases sales from 500 to 650 units per month?



Change in Fixed Cost, Sales Price and Volume

The screenshot shows a Microsoft Excel spreadsheet titled "Racing Bicycle Company Contribution Income Statement For the Month of June". The spreadsheet compares current sales (500 bikes) with projected sales (650 bikes). The data is presented in a table with three columns: Current Sales, Projected Sales, and the difference.

	Current Sales (500 bikes)	Projected Sales (650 bikes)
Sales revenue	\$ 250,000	\$ 312,000
Less: Variables expenses	150,000	195,000
Contribution margin	100,000	117,000
Less: Fixed expenses	80,000	95,000
Net income	\$ 20,000	\$ 22,000

Sales **increase** by \$62,000, fixed costs increase by \$15,000, and net operating income **increases** by \$2,000.

Change in Variable Cost, Fixed Cost and Sales Volume

What is the profit impact if Racing (1) pays a \$15 sales commission per bike sold instead of paying salespersons flat salaries that currently total \$6,000 per month, and (2) increases unit sales from 500 to 575 bikes?



Change in Variable Cost, Fixed Cost and Sales Volume

		Racing Bicycle Company			
		Contribution Income Statement			
		For the Month of June			
		Current Sales	Projected Sales		
		(500 bikes)	(575 bikes)		
7	Sales revenue	\$ 250,000	\$ 287,500		
8	Less: Variables expenses	150,000	181,125		
9	Contribution margin	100,000	106,375		
10	Less: Fixed expenses	80,000	74,000		
11	Net income	\$ 20,000	\$ 32,375		

Sales **increase** by \$37,500, variable costs **increase** by \$31,125, but fixed expenses **decrease** by \$6,000.

Change in Regular Sales Price

If Racing has an opportunity to sell 150 bikes to a wholesaler without disturbing sales to other customers or fixed expenses, what price would it quote to the wholesaler if it wants to increase monthly profits by \$3,000?



Change in Regular Sales Price

$$\$ 3,000 \div 150 \text{ bikes} = \$ 20 \text{ per bike}$$

$$\text{Variable cost per bike} = \underline{\underline{300}} \text{ per bike}$$

$$\text{Selling price required} = \underline{\underline{\$ 320}} \text{ per bike}$$

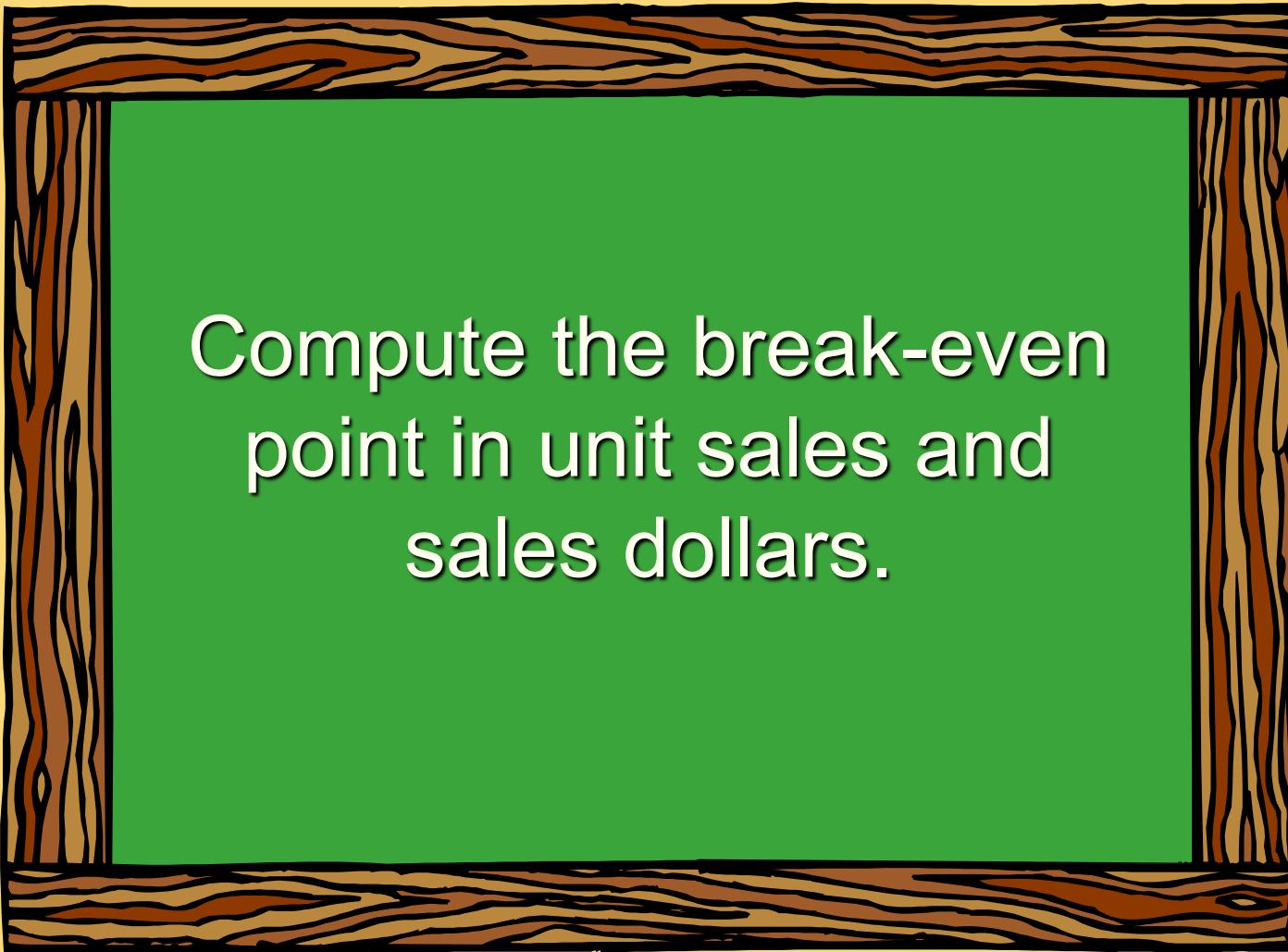
$$150 \text{ bikes} \times \$320 \text{ per bike} = \$ 48,000$$

$$\text{Total variable costs} = \underline{\underline{45,000}}$$

$$\text{Increase in net income} = \underline{\underline{\$ 3,000}}$$



Learning Objective 5

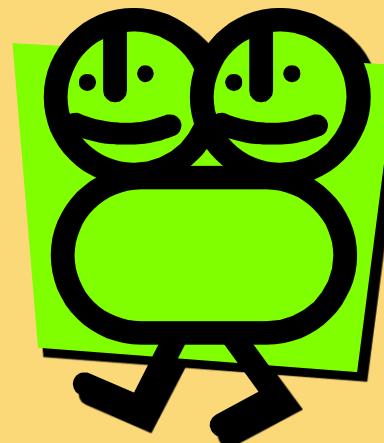


Compute the break-even point in unit sales and sales dollars.

Break-Even Analysis

Break-even analysis can be approached in two ways:

1. Equation method
2. Contribution margin method



Equation Method

Profits = (Sales – Variable expenses) – Fixed expenses

OR

Sales = Variable expenses + Fixed expenses + Profits

**At the break-even point
profits equal zero**



Break-Even Analysis

Here is the information from Racing Bicycle Company:

	Total	Per Unit	Percent
Sales (500 bikes)	\$ 250,000	\$ 500	100%
Less: variable expenses	150,000	300	60%
Contribution margin	\$ 100,000	\$ 200	40%
Less: fixed expenses	80,000		
Net operating income	<u><u>\$ 20,000</u></u>		



Equation Method

- We calculate the break-even point as follows:

Sales = Variable expenses + Fixed expenses + Profits

$$\$500Q = \$300Q + \$80,000 + \$0$$

Where:

Q = Number of bikes sold

\$500 = Unit selling price

\$300 = Unit variable expense

\$80,000 = Total fixed expense



Equation Method

- We calculate the break-even point as follows:

Sales = Variable expenses + Fixed expenses + Profits

$$\$500Q = \$300Q + \$80,000 + \$0$$

$$\$200Q = \$80,000$$

$$Q = \$80,000 \div \$200 \text{ per bike}$$

$$Q = 400 \text{ bikes}$$



Equation Method

- The equation can be modified to calculate the break-even point in sales dollars.

Sales = Variable expenses + Fixed expenses + Profits

$$X = 0.60X + \$80,000 + \$0$$

Where:

X = Total **sales dollars**

0.60 = Variable expenses as a % of sales

\$80,000 = Total fixed expenses



Equation Method

- The equation can be modified to calculate the break-even point in sales dollars.

Sales = Variable expenses + Fixed expenses + Profits

$$X = 0.60X + \$80,000 + \$0$$

$$0.40X = \$80,000$$

$$X = \$80,000 \div 0.40$$

$$X = \$200,000$$



Contribution Margin Method

The contribution margin method has two key equations.

$$\text{Break-even point in units sold} = \frac{\text{Fixed expenses}}{\text{CM per unit}}$$

$$\text{Break-even point in total sales dollars} = \frac{\text{Fixed expenses}}{\text{CM ratio}}$$



Contribution Margin Method

Let's use the contribution margin method to calculate the break-even point in total sales dollars at Racing.

$$\text{Break-even point in total sales dollars} = \frac{\text{Fixed expenses}}{\text{CM ratio}}$$

$$\frac{\$80,000}{40\%} = \$200,000 \text{ break-even sales}$$



Quick Check ✓

Coffee Klatch is an espresso stand in a downtown office building. The average selling price of a cup of coffee is \$1.49 and the average variable expense per cup is \$0.36. The average fixed expense per month is \$1,300. 2,100 cups are sold each month on average. What is the break-even sales in units?

- a. 872 cups
- b. 3,611 cups
- c. 1,200 cups
- d. 1,150 cups

Quick Check ✓

Coffee Klatch is an espresso stand in a downtown office building. The average selling price of a cup of coffee is \$1.49. Variable expense per cup is \$0.36. Fixed expenses per month are \$1,300. How many cups must be sold each month on average to break even? Express sales in units?

- a. 872 cups
- b. 3,611 cups
- c. 1,200 cups
- d. 1,150 cups

$$\begin{aligned}\text{Break-even} &= \frac{\text{Fixed expenses}}{\text{CM per Unit}} \\ &= \frac{\$1,300}{\$1.49/\text{cup} - \$0.36/\text{cup}} \\ &= \frac{\$1,300}{\$1.13/\text{cup}} \\ &= 1,150 \text{ cups}\end{aligned}$$

Quick Check ✓

Coffee Klatch is an espresso stand in a downtown office building. The average selling price of a cup of coffee is \$1.49 and the average variable expense per cup is \$0.36. The average fixed expense per month is \$1,300. 2,100 cups are sold each month on average. What is the break-even sales in dollars?

- a. \$1,300
- b. \$1,715
- c. \$1,788
- d. \$3,129

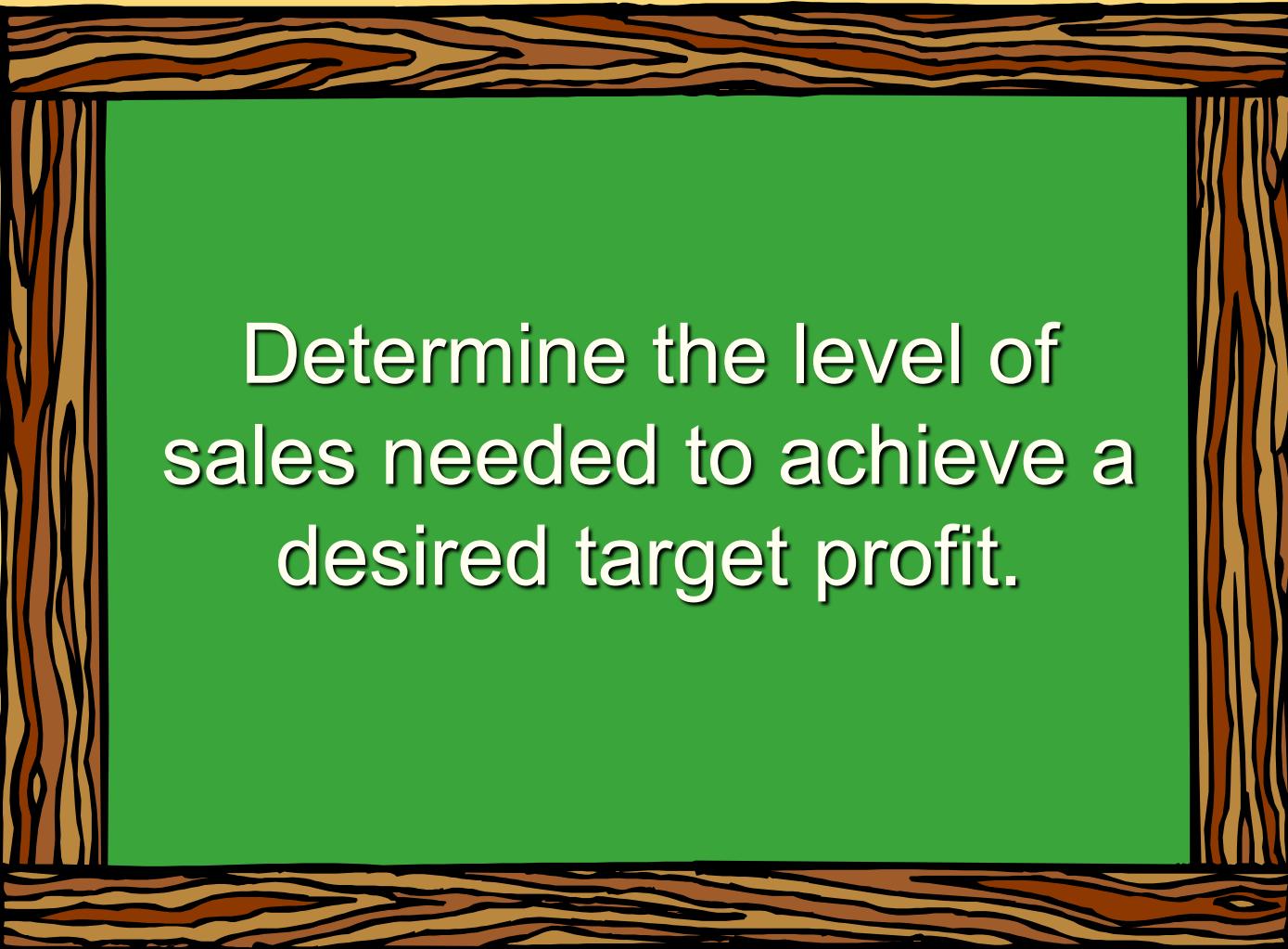
Quick Check ✓

Coffee Klatch is an espresso stand in a downtown office building. The average selling price of a cup of coffee is \$1.49 and the average variable expense per cup is \$0.36. The average fixed expense per month is \$1,300. 2,100 cups are sold each month on average. What is the break-even sales in dollars?

- a. \$1,300
- b. \$1,715**
- c. \$1,788
- d. \$3,129

$$\begin{aligned}\text{Break-even sales} &= \frac{\text{Fixed expenses}}{\text{CM Ratio}} \\ &= \frac{\$1,300}{0.758} \\ &= \$1,715\end{aligned}$$

Learning Objective 6



Determine the level of sales needed to achieve a desired target profit.

Target Profit Analysis

The equation and contribution margin methods can be used to determine the sales volume needed to achieve a target profit.

Suppose Racing Bicycle Company wants to know how many bikes must be sold to earn a profit of \$100,000.



The CVP Equation Method

Sales = Variable expenses + Fixed expenses + Profits

$$\$500Q = \$300Q + \$80,000 + \$100,000$$

$$\$200Q = \$180,000$$

$$Q = 900 \text{ bikes}$$



The Contribution Margin Approach

The contribution margin method can be used to determine that 900 bikes must be sold to earn the target profit of \$100,000.

$$\text{Unit sales to attain} \quad = \quad \frac{\text{Fixed expenses} + \text{Target profit}}{\text{CM per unit}}$$

the target profit

$$\frac{\$80,000 + \$100,000}{\$200/\text{bike}} = 900 \text{ bikes}$$



Quick Check ✓

Coffee Klatch is an espresso stand in a downtown office building. The average selling price of a cup of coffee is \$1.49 and the average variable expense per cup is \$0.36. The average fixed expense per month is \$1,300. How many cups of coffee would have to be sold to attain target profits of \$2,500 per month?

- a. 3,363 cups
- b. 2,212 cups
- c. 1,150 cups
- d. 4,200 cups

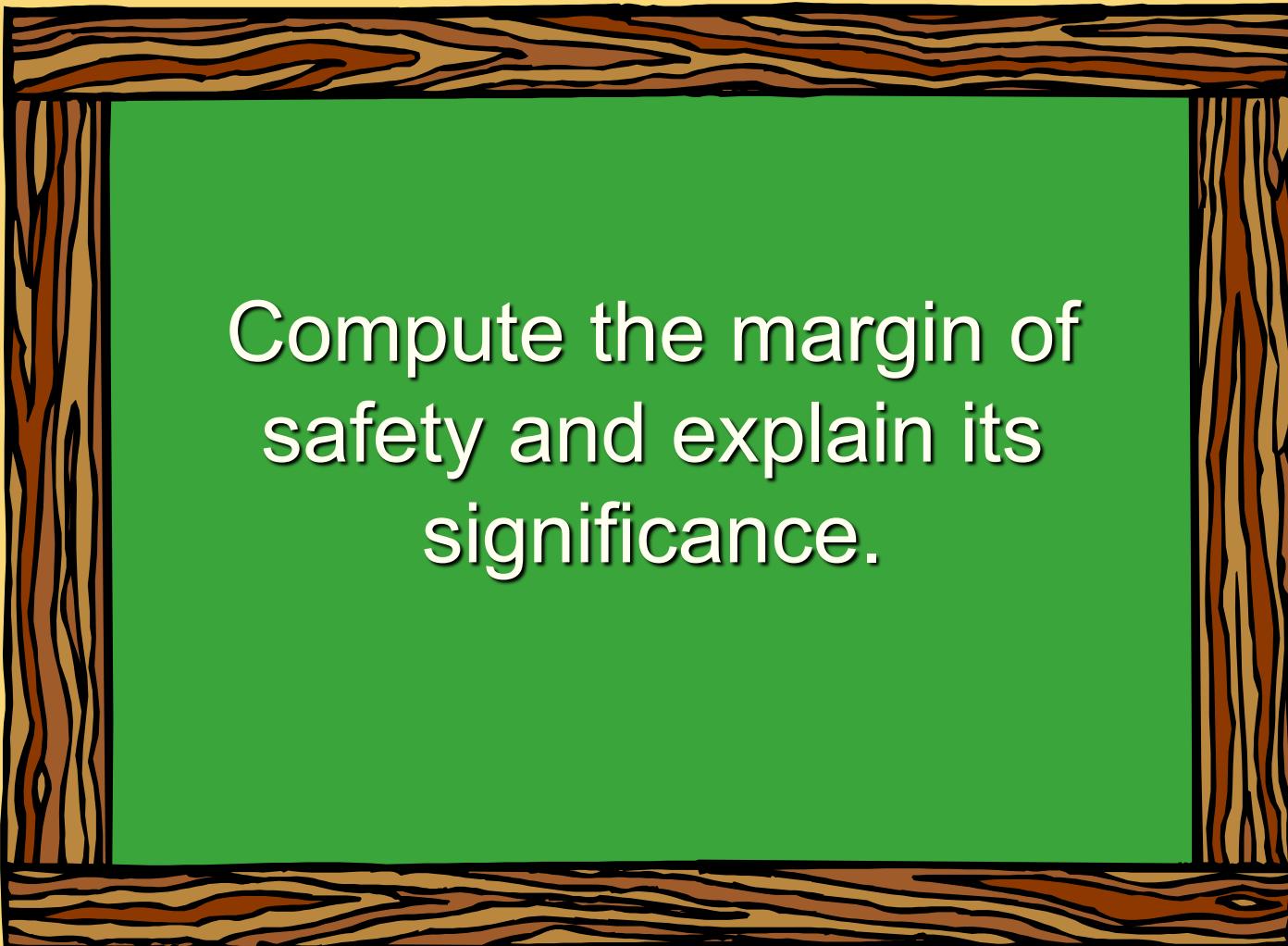
Quick Check ✓

Coffee
office b
coffee
per cup
month
have to
month?

$$\begin{aligned}\text{Unit sales} &= \frac{\text{Fixed expenses} + \text{Target profit}}{\text{Unit CM}} \\ &= \frac{\$1,300 + \$2,500}{\$1.49 - \$0.36} \\ &= \frac{\$3,800}{\$1.13} \\ &= 3,363 \text{ cups}\end{aligned}$$

- a. 3,363 cups
- b. 2,212 cups
- c. 1,150 cups
- d. 4,200 cups

Learning Objective 7



Compute the margin of safety and explain its significance.

The Margin of Safety



The margin of safety is the excess of budgeted (or actual) sales over the break-even volume of sales.

Margin of safety = Total sales - Break-even sales

Let's look at Racing Bicycle Company and determine the margin of safety.



The Margin of Safety

If we assume that Racing Bicycle Company has actual sales of \$250,000, given that we have already determined the break-even sales to be \$200,000, the margin of safety is \$50,000 as shown.



	Break-even sales 400 units	Actual sales 500 units
Sales	\$ 200,000	\$ 250,000
Less: variable expenses	<u>120,000</u>	<u>150,000</u>
Contribution margin	80,000	100,000
Less: fixed expenses	<u>80,000</u>	<u>80,000</u>
Net operating income	<u><u>\$ -</u></u>	<u><u>\$ 20,000</u></u>

The Margin of Safety

The margin of safety can be expressed as
20% of sales.

$$(\$50,000 \div \$250,000)$$



	Break-even	
	sales	Actual sales
	400 units	500 units
Sales	\$ 200,000	\$ 250,000
Less: variable expenses	<u>120,000</u>	<u>150,000</u>
Contribution margin	80,000	100,000
Less: fixed expenses	<u>80,000</u>	<u>80,000</u>
Net operating income	<u>\$ -</u>	<u>\$ 20,000</u>

The Margin of Safety

The margin of safety can be expressed in terms of the number of units sold. The margin of safety at Racing is \$50,000, and each bike sells for \$500.

$$\text{Margin of Safety in units} = \frac{\$50,000}{\$500} = 100 \text{ bikes}$$



Quick Check ✓

Coffee Klatch is an espresso stand in a downtown office building. The average selling price of a cup of coffee is \$1.49 and the average variable expense per cup is \$0.36. The average fixed expense per month is \$1,300. 2,100 cups are sold each month on average. What is the margin of safety?

- a. 3,250 cups
- b. 950 cups
- c. 1,150 cups
- d. 2,100 cups

Quick Check ✓

Coffee
office
coffee
per cup
months
on average

a. 3

b.

950 cups

c. 1,150 cups

d. 2,100 cups

$$\begin{aligned}\text{Margin of safety} &= \text{Total sales} - \text{Break-even sales} \\ &= 2,100 \text{ cups} - 1,150 \text{ cups} \\ &= \mathbf{950 \text{ cups}}\end{aligned}$$

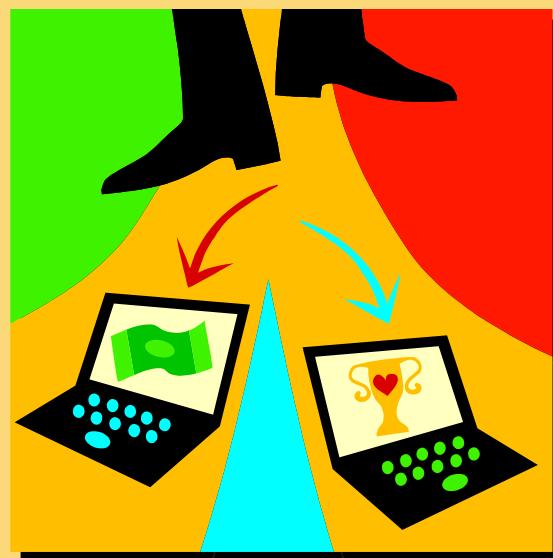
or

$$\text{Margin of safety percentage} = \frac{950 \text{ cups}}{2,100 \text{ cups}} = \mathbf{45\%}$$

Cost Structure and Profit Stability

Cost structure refers to the relative proportion of fixed and variable costs in an organization.

Managers often have some latitude in determining their organization's cost structure.



Cost Structure and Profit Stability

There are advantages and disadvantages to high fixed cost (or low variable cost) and low fixed cost (or high variable cost) structures.

An advantage of a high fixed cost structure is that income will be higher in good years compared to companies with lower proportion of fixed costs.

A disadvantage of a high fixed cost structure is that income will be lower in bad years compared to companies with lower proportion of fixed costs.

Quick Check ✓

Coffee Klatch is an espresso stand in a downtown office building. The average selling price of a cup of coffee is \$1.49 and the average variable expense per cup is \$0.36. The average fixed expense per month is \$1,300. 2,100 cups are sold each month on average. What is the operating leverage?

- a. 2.21
- b. 0.45
- c. 0.34
- d. 2.92

Quick Check ✓

Coffee Klatch is an espresso bar located in a downtown office building. The selling price of a cup of coffee is \$1.50. The average variable cost per cup is \$0.36. The average fixed expense per day is \$1,300. 2,100 cups of coffee are sold on average. What is the operating leverage?

	<i>Actual sales</i>
	<i>2,100 cups</i>
Sales	\$ 3,129
Less: Variable expenses	<u>756</u>
Contribution margin	2,373
Less: Fixed expenses	<u>1,300</u>
Net operating income	<u><u>\$ 1,073</u></u>

- a. 2.21
- b. 0.45
- c. 0.34
- d. 2.92

$$\begin{aligned} \text{Operating leverage} &= \frac{\text{Contribution margin}}{\text{Net operating income}} \\ &= \frac{\$2,373}{\$1,073} = 2.21 \end{aligned}$$

Quick Check ✓

At Coffee Klatch the average selling price of a cup of coffee is \$1.49, the average variable expense per cup is \$0.36, the average fixed expense per month is \$1,300 and an average of 2,100 cups are sold each month.

If sales increase by 20%, by how much should net operating income increase?

- a. 30.0%
- b. 20.0%
- c. 22.1%
- d. 44.2%

Quick Check ✓

At Coffee Klatch the average selling price of a cup of coffee is \$1.49, the average variable expense per cup is \$0.36, the average fixed expense per month is \$1,300 and an average of 2,100 cups are sold each month.

If sales increase by 20%, by how much should net operating income increase?

- a. 30.0%
- b. 20.0%
- c. 22.1%
- d. 44.2%

Percent increase in sales	20.0%
× Degree of operating leverage	2.21
Percent increase in profit	44.20%

Verify Increase in Profit

	<i>Actual sales</i>	<i>Increased sales</i>
Sales	2,100 cups	2,520 cups
Less: Variable expenses	\$ 3,129	\$ 3,755
Contribution margin	756	907
Less: Fixed expenses	2,373	2,848
Net operating income	1,300	1,300
	\$ 1,073	\$ 1,548
% change in sales		20.0%
% change in net operating income		44.2%

Structuring Sales Commissions

Companies generally compensate salespeople by paying them either a commission based on sales or a salary plus a sales commission. Commissions based on sales dollars can lead to lower profits in a company.

Let's look at an example.

Structuring Sales Commissions

Pipeline Unlimited produces two types of surfboards, the XR7 and the Turbo. The XR7 sells for \$100 and generates a contribution margin per unit of \$25. The Turbo sells for \$150 and earns a contribution margin per unit of \$18.

The sales force at Pipeline Unlimited is compensated based on sales commissions.



Structuring Sales Commissions

If you were on the sales force at Pipeline, you would push hard to sell the Turbo even though the XR7 earns a higher contribution margin per unit.

To eliminate this type of conflict, commissions can be based on contribution margin rather than on selling price alone.

