

SECOND EDITION

Managerial Accounting



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Cost-Volume-Profit Relationships

Chapter 4

Learning Objective 1

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





Basics of Cost-Volume-Profit Analysis

The contribution income statement is helpful to managers in judging the impact on profits of changes in selling price, cost, or volume. The emphasis is on cost behavior.

Racing Bicycle Company Contribution Income Statement For the Month of June		
Sales (500 bicycles)	\$	250,000
Less: Variable expenses		150,000
Contribution margin		100,000
Less: Fixed expenses		80,000
Net operating 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

**Racing Bicycle Company
Contribution Income Statement
For the Month of June**

Sales (500 bicycles)	\$ 250,000
Less: Variable expenses	150,000
Contribution margin	100,000
Less: Fixed expenses	80,000
Net operating 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.

Racing Bicycle Company
Contribution Income Statement
For the Month of June

	Total	Per Unit
Sales (500 bicycles)	\$ 250,000	\$ 500
Less: Variable expenses	<u>150,000</u>	300
Contribution margin	<u>100,000</u>	<u>\$ 200</u>
Less: Fixed expenses	<u>80,000</u>	
Net operating income	<u>\$ 20,000</u>	



The Contribution Approach

Each month, RBC must generate at least \$80,000 in total contribution margin to break-even (which is the level of sales at which profit is zero).

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



The Contribution Approach

If RBC 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
Sales (400 bicycles)	\$ 200,000	\$ 500
Less: Variable expenses	120,000	300
Contribution margin	80,000	\$ 200
Less: Fixed expenses	80,000	
Net operating income	\$ -	



The Contribution Approach

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

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

If Racing sells
430 bikes, its net
operating income
will be \$6,000.





CVP Relationships in Equation Form

The contribution format income statement can be expressed in the following equation:

Profit = (Sales – Variable expenses) – Fixed expenses

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



CVP Relationships in Equation Form

This equation can be used to show the profit RBC earns if it sells 401. Notice, the answer of \$200 mirrors our earlier solution.

Profit = (Sales – Variable expenses) – Fixed expenses

401 units × \$500

401 units × \$300

\$80,000

$$\$200 = (\$200,500 - \$120,300) - \$80,000$$



CVP Relationships in Equation Form

When a company has only one product we can further refine this equation as shown on this slide.

$$\text{Profit} = (\text{Sales} - \text{Variable expenses}) - \text{Fixed expenses}$$

$$\begin{aligned}\text{Quantity sold (Q)} \\ \times \text{Selling price per unit (P)} \\ = \text{Sales (Q} \times P)\end{aligned}$$

$$\begin{aligned}\text{Quantity sold (Q)} \\ \times \text{Variable expenses per unit (V)} \\ = \text{Variable expenses (Q} \times V)\end{aligned}$$

$$\text{Profit} = (P \times Q - V \times Q) - \text{Fixed expenses}$$



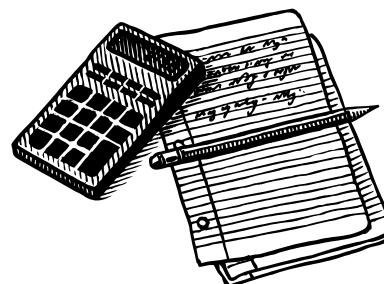
CVP Relationships in Equation Form

This equation can also be used to show the \$200 profit RBC earns if it sells 401 bikes.

Profit = (Sales – Variable expenses) – Fixed expenses

Profit = ($P \times Q - V \times Q$) – Fixed expenses

$$\$200 = (\$500 \times 401 - \$300 \times 401) - \$80,000$$





CVP Relationships in Equation Form

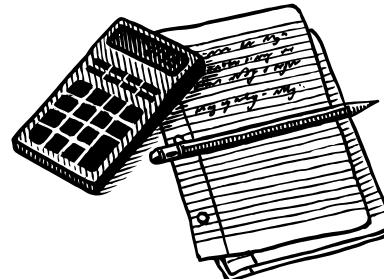
It is often useful to express the simple profit equation in terms of the unit contribution margin (Unit CM) as follows:

Unit CM = Selling price per unit – Variable expenses per unit
Unit CM = $P - V$

Profit = $(P \times Q - V \times Q) - \text{Fixed expenses}$

Profit = $(P - V) \times Q - \text{Fixed expenses}$

Profit = **Unit CM** $\times Q - \text{Fixed expenses}$





CVP Relationships in Equation Form

Profit = $(P \times Q - V \times Q) - \text{Fixed expenses}$

Profit = $(P - V) \times Q - \text{Fixed expenses}$

Profit = **Unit CM** $\times Q - \text{Fixed expenses}$

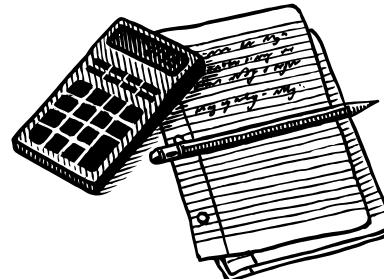
$$\text{Profit} = (\$500 - \$300) \times 401 - \$80,000$$

$$\text{Profit} = \$200 \times 401 - \$80,000$$

$$\text{Profit} = \$80,200 - \$80,000$$

$$\text{Profit} = \$200$$

This equation can also be used to compute RBC's \$200 profit if it sells 401 bikes.



Learning Objective 2

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





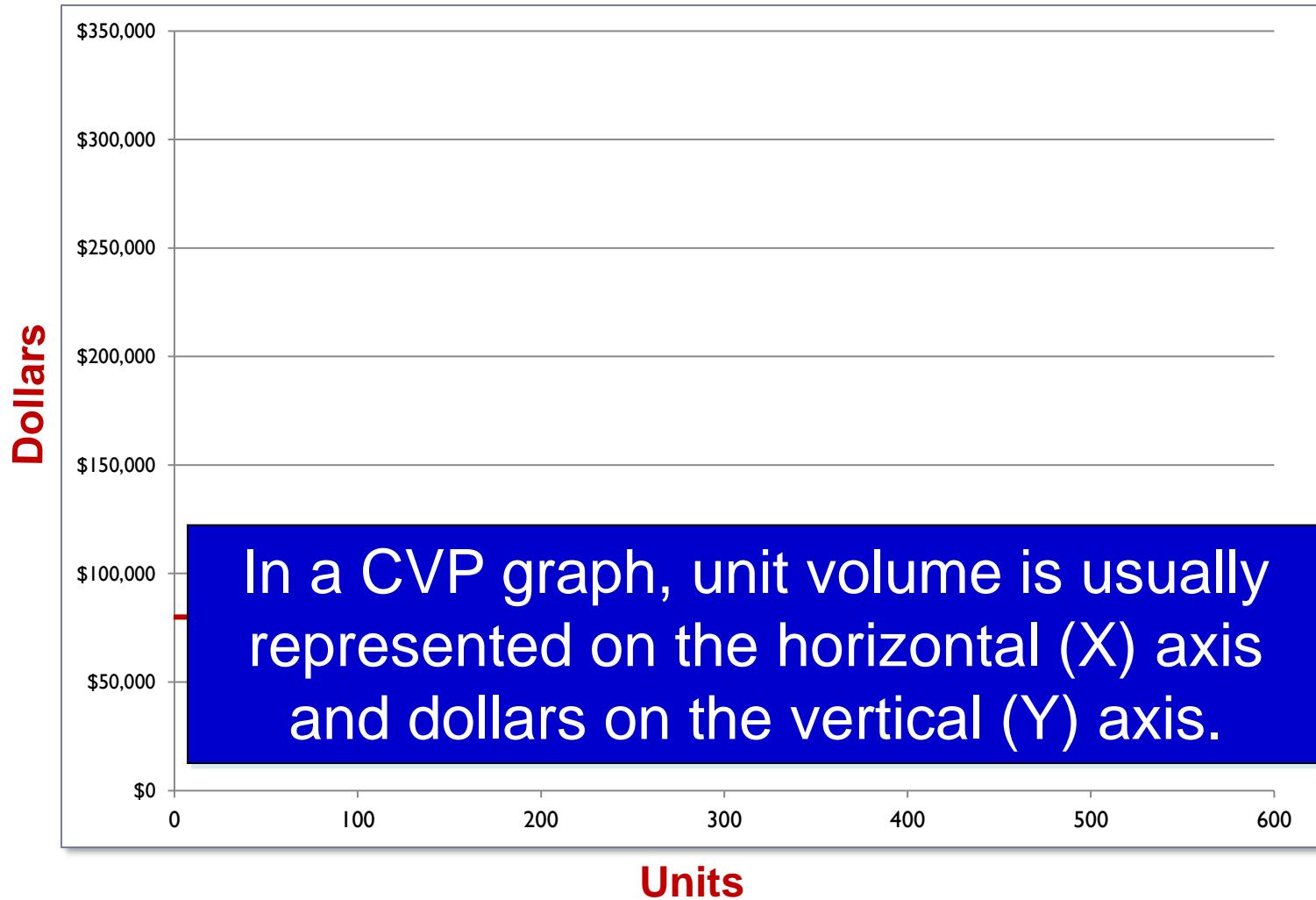
CVP Relationships in Graphic Form

The relationships among revenue, cost, profit and volume can be expressed graphically by preparing a CVP graph. Racing Bicycle developed contribution margin income statements at 0, 200, 400, and 600 units sold. We will use this information to prepare the CVP graph.

	Units Sold			
	0	200	400	600
Sales	\$ -	\$ 100,000	\$ 200,000	\$ 300,000
Total variable expenses	-	60,000	120,000	180,000
Contribution margin	-	40,000	80,000	120,000
Fixed expenses	80,000	80,000	80,000	80,000
Net operating income (loss)	\$ (80,000)	\$ (40,000)	\$ -	\$ 40,000

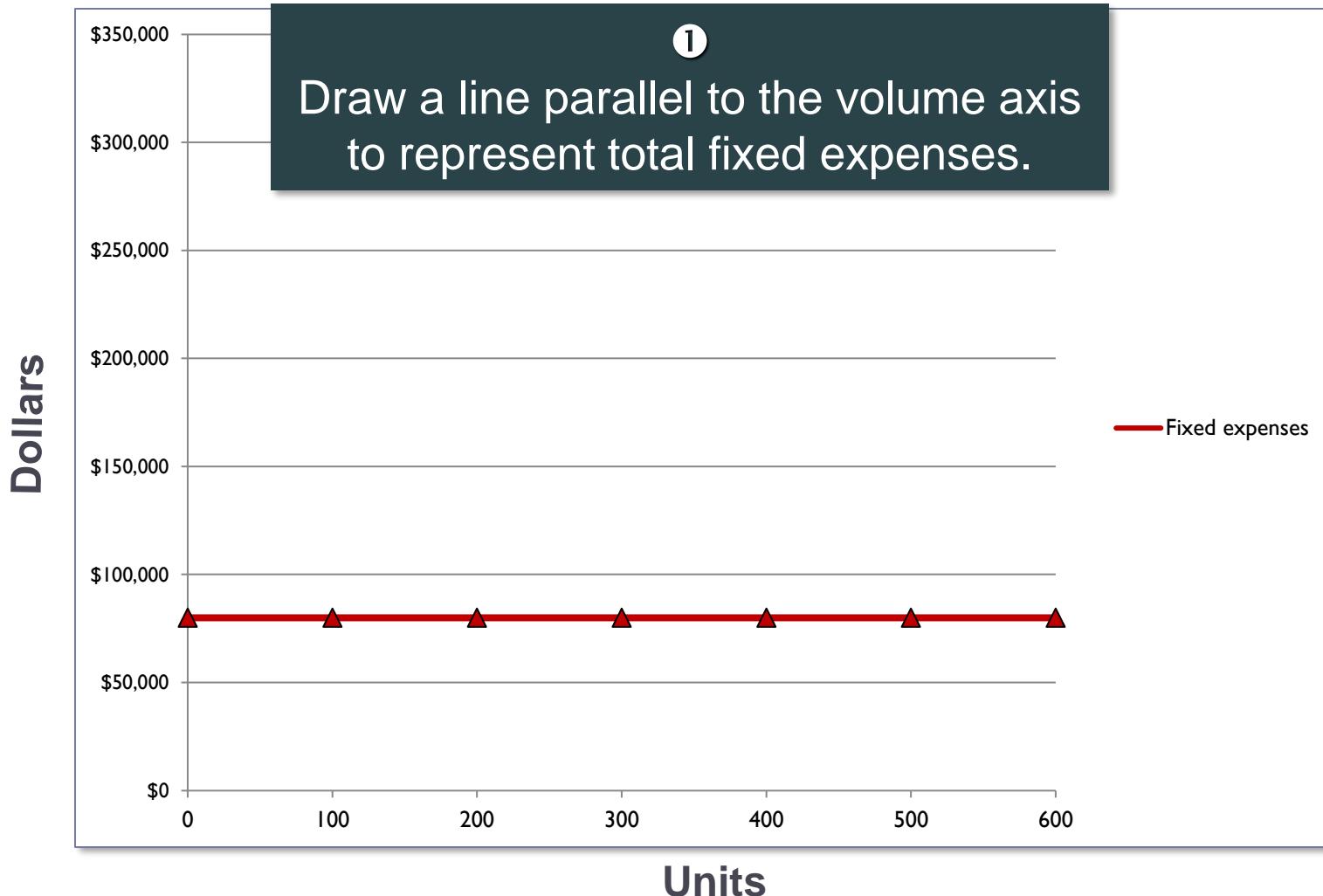


Preparing the CVP Graph





Preparing the CVP Graph

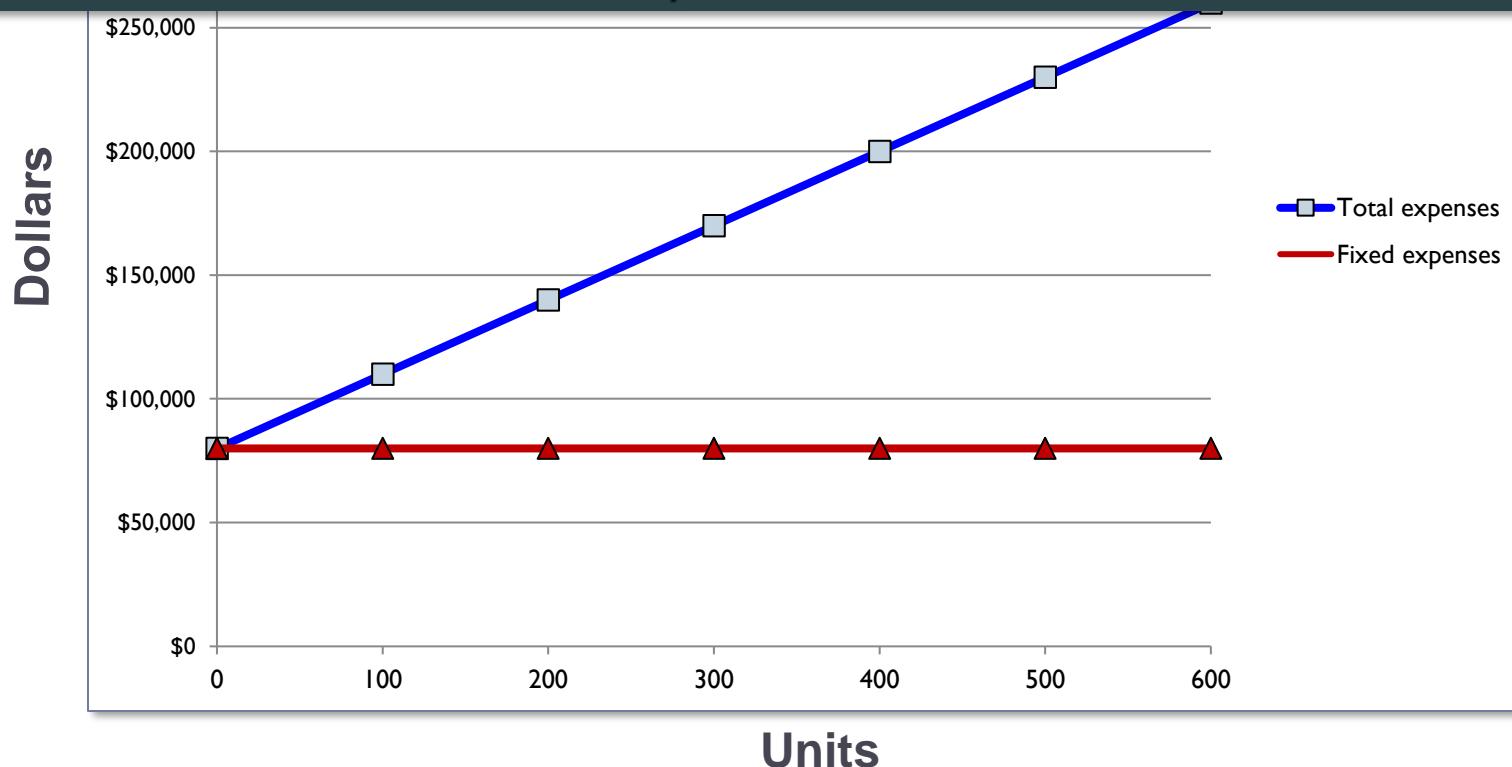




Preparing the CVP Graph

②

Choose some sales volume, say 400 units, and plot the point representing total expenses (fixed and variable). Draw a line through the data point back to where the fixed expenses line intersects the dollar axis.

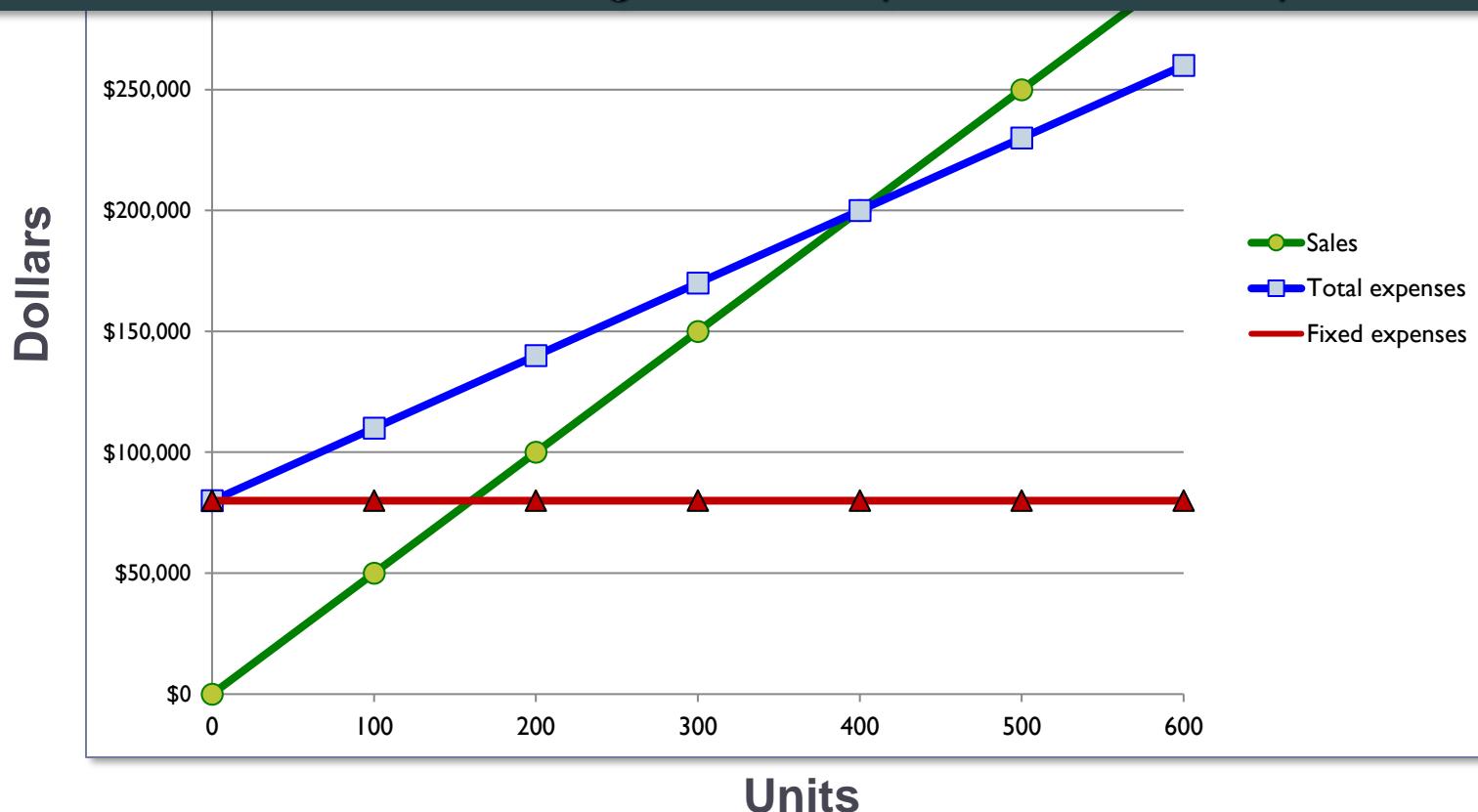




Preparing the CVP Graph

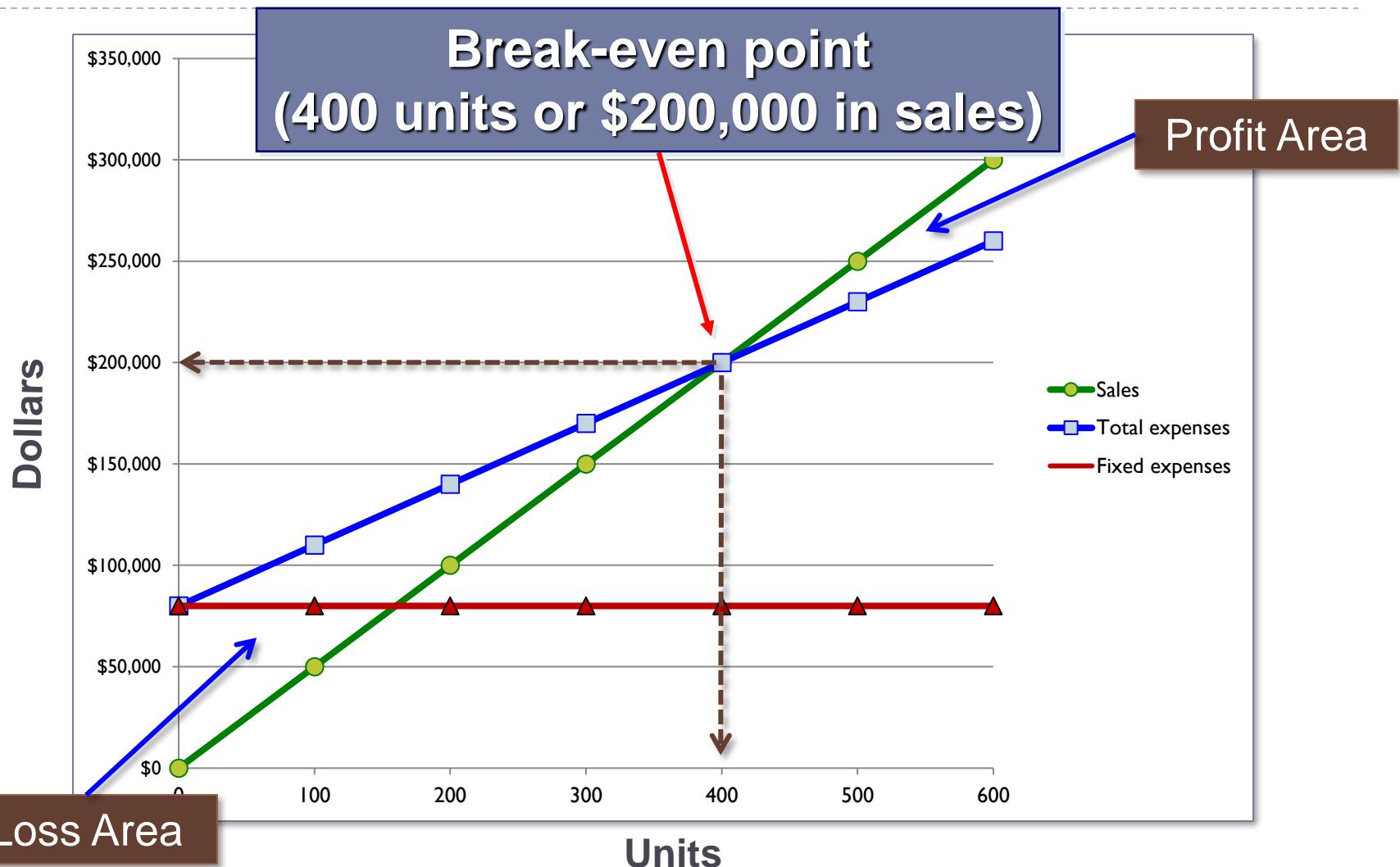
③

Choose some sales volume, say 400 units, and plot the point representing total sales. Draw a line through the data point back to the point of origin.



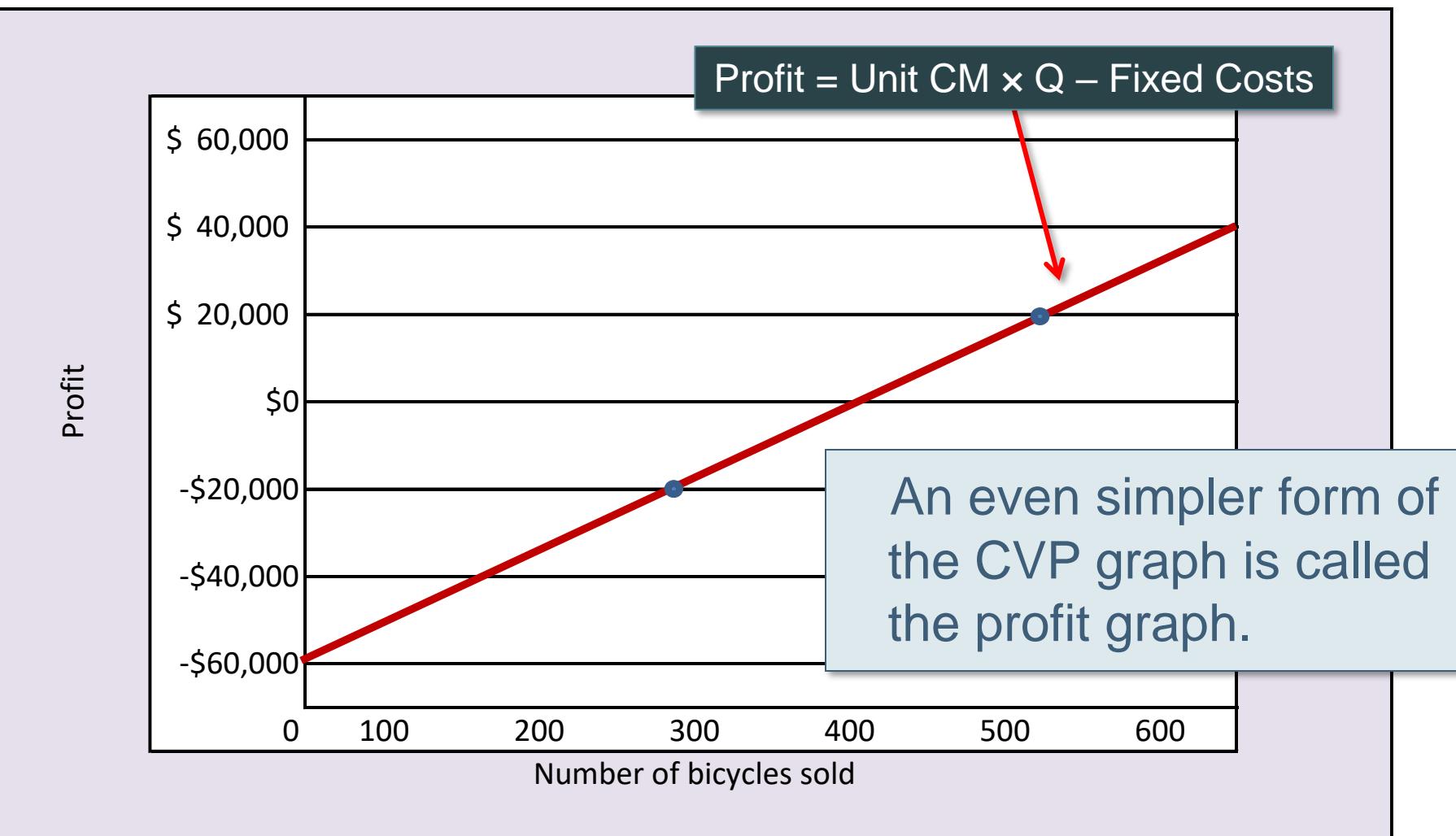


Preparing the CVP Graph



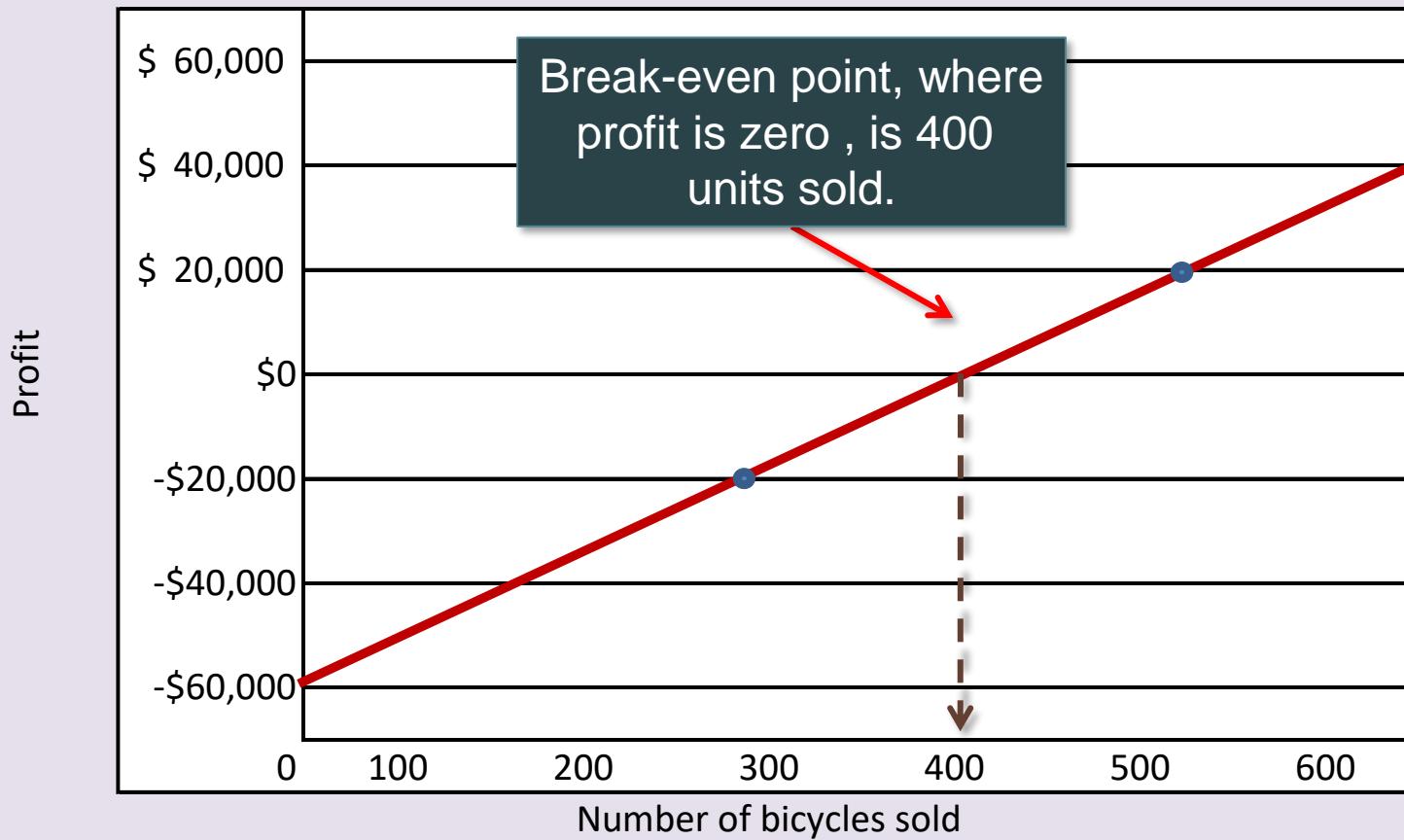


Preparing the CVP Graph





Preparing the 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 (CM Ratio)

The CM ratio is calculated by dividing the total contribution margin by total sales.

Racing Bicycle Company Contribution Income Statement For the Month of June			
	Total	Per Unit	CM Ratio
Sales (500 bicycles)	\$ 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	\$ 20,000		

$$\$100,000 \div \$250,000 = 40\%$$



Contribution Margin Ratio (CM Ratio)

The contribution margin ratio at Racing Bicycle is:

$$\text{CM Ratio} = \frac{\text{CM per unit}}{\text{SP per unit}} = \frac{\$200}{\$500} = 40\%$$

The CM ratio can also be calculated by dividing the contribution margin per unit by the selling price per unit.





Contribution Margin Ratio (CM Ratio)

If Racing Bicycle increases sales by \$50,000, contribution margin will increase by \$20,000 ($\$50,000 \times 40\%$).

Here is the proof:

	400 Units	500 Units
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

$$\begin{aligned}\text{CM Ratio} &= \frac{\text{Unit contribution margin}}{\text{Unit selling price}} \\ &= \frac{(\$1.49 - \$0.36)}{\$1.49} \\ &= \frac{\$1.13}{\$1.49} = 0.758\end{aligned}$$



Contribution Margin Ratio (CM Ratio)

The relationship between profit and the CM ratio can be expressed using the following equation:

$$\text{Profit} = \text{CM ratio} \times \text{Sales} - \text{Fixed expenses}$$

If Racing Bicycle increased its sales volume to 500 bikes, what would management expect profit or net operating income to be?

$$\text{Profit} = 40\% \times \$250,000 - \$80,000$$

$$\text{Profit} = \$100,000 - \$80,000$$

$$\text{Profit} = \$20,000$$



Learning Objective 4

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





The Variable Expense Ratio

The variable expense ratio is the ratio of variable expenses to sales. It can be computed by dividing the total variable expenses by the total sales, or in a single product analysis, it can be computed by dividing the variable expenses per unit by the unit selling price.

Racing Bicycle Company Contribution Income Statement For the Month of June			
	Total	Per Unit	CM Ratio
Sales (500 bicycles)	\$ 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>		





Changes in Fixed Costs and Sales Volume

What is the profit impact if Racing Bicycle 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

	500 units	540 units
Sales	\$ 250,000	\$ 270,000
Less: Variable expenses	150,000	162,000
Contribution margin	100,000	108,000
Less: Fixed expenses	80,000	90,000
Net operating income	<u>\$ 20,000</u>	<u>\$ 18,000</u>

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



Changes in Fixed Costs and Sales Volume

A shortcut solution using incremental analysis

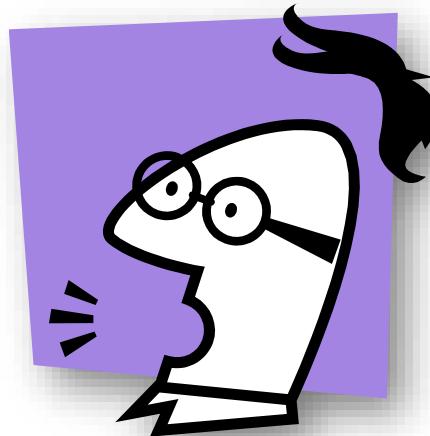
Increase in CM (40 units X \$200)	\$ 8,000
Increase in advertising expenses	<u>10,000</u>
Decrease in net operating income	<u><u>\$ (2,000)</u></u>





Change in Variable Costs and Sales Volume

What is the profit impact if Racing Bicycle 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

	500 units	580 units
Sales	\$ 250,000	\$ 290,000
Less: Variable expenses	150,000	179,800
Contribution margin	100,000	110,200
Less: Fixed expenses	80,000	80,000
Net operating 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 RBC: (1) cuts its selling price by \$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



$$650 \text{ units} \times \$480 = \$312,000$$

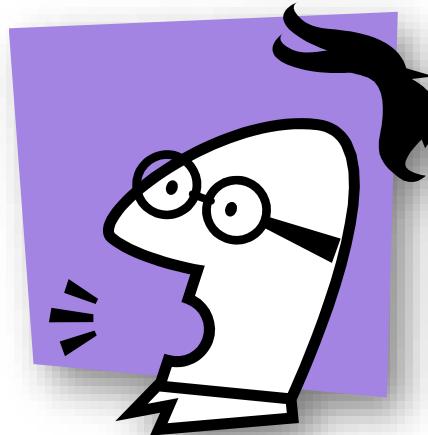
	500 units	650 units
Sales	\$ 250,000	\$ 312,000
Less: Variable expenses	150,000	195,000
Contribution margin	100,000	117,000
Less: Fixed expenses	80,000	95,000
Net operating income	\$ 20,000	\$ 22,000

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 RBC: (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

$$575 \text{ units} \times \$315 = \$181,125$$

	<u>500 units</u>	<u>575 units</u>
Sales	\$ 250,000	\$ 287,500
Less: Variable expenses	<u>150,000</u>	<u>181,125</u>
Contribution margin	100,000	106,375
Less: Fixed expenses	<u>80,000</u>	<u>74,000</u>
Net operating income	<u><u>\$ 20,000</u></u>	<u><u>\$ 32,375</u></u>

Sales **increase** by \$37,500, fixed expenses **decrease** by \$6,000. Net operating income **increases** by \$12,375.



Change in Regular Sales Price

If RBC 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

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

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

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

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

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

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



Learning Objective 5

Determine the break-even point.





Break-even Analysis

Let's use the RBC information to complete the break-even analysis.

Racing Bicycle Company Contribution Income Statement For the Month of June			
	Total	Per Unit	CM Ratio
Sales (500 bicycles)	\$ 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	\$ 20,000		



Break-even Analysis

We can use any of the following methods to do break-even analysis:

1. Equation method
2. Formula method
3. Percentage method



Break-even in Unit Sales: Equation Method



Profits = Unit CM × Q – Fixed expenses

**Suppose RBC wants to know how many
bikes must be sold to break-even
(earn zero profit).**

$$\rightarrow \$0 = \$200 \times Q + \$80,000$$

Profits are zero at the break-even point.



Break-even in Unit Sales: Equation Method



Profits = Unit CM × Q – Fixed expenses

$$\$0 = \$200 \times Q + \$80,000$$

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

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



Break-even in Unit Sales: Formula Method



Let's apply the formula method to solve for the break-even point.

$$\text{Unit sales to break even} = \frac{\text{Fixed expenses}}{\text{CM per unit}}$$

$$\text{Unit sales} = \frac{\$80,000}{\$200}$$

$$\text{Unit sales} = 400$$



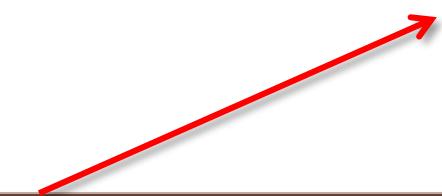
Break-even in Dollar Sales: Equation Method



Suppose Racing Bicycle wants to compute the sales dollars required to break-even (zero profit). Let's use the equation method to solve this problem.

Profit = CM ratio × Sales – Fixed expenses

Solve for the unknown “Sales.”



Break-even in Dollar Sales: Equation Method



Profit = CM ratio × Sales – Fixed expenses

$$\$0 = 40\% \times \text{Sales} - \$80,000$$

$$40\% \times \text{Sales} = \$80,000$$

$$\text{Sales} = \$80,000 \div 40\%$$

$$\text{Sales} = \$200,000$$



Break-even in Dollar Sales: Formula Method



Now, let's use the formula method to calculate the dollar sales at the break-even point.

$$\text{Dollar sales to break even} = \frac{\text{Fixed expenses}}{\text{CM ratio}}$$

$$\text{Dollar sales} = \frac{\$80,000}{40\%}$$

$$\text{Dollar sales} = \$200,000$$





Break-even: The Percentage Method

Now, let's use the 3rd method: the break-even percentage (BE%) method to calculate the break-even point in units as well as in sales \$. This method also efficiently calculates break-even for multiple products.

$$BE\% = \frac{BE \text{ Sales \$}}{\text{Total Sales \$}} \times 100\%$$

$$\text{Since BE Sales \$} = \frac{FE}{CM\%}$$

$$\Rightarrow BE\% = \frac{\frac{FE}{CM\%}}{\text{Total Sales \$}} \times 100\%$$

$$\text{Since CM\%} \times \text{Total Sales \$} = CM$$

$$\Rightarrow BE\% = \frac{FE}{CM} \times 100\%$$

Break-even Units and Dollars: The Percentage Method



Applying the BE% formula to the same company RBC

$$\text{BE\%} = \frac{\text{FE}}{\text{CM}} \times 100\%$$

$$\text{BE\%} = \frac{\$80,000}{\$100,000} \times 100\% = 80\%$$

- ✓ This means that the company requires 80% of its current sales in order to break-even.
- ✓ Currently, the company's sales are \$250,000 or 500 units.
- ✓ A BE% of 80% means if the company sales are \$200,000 ($\$250,000 \times 80\%$) or 400 units (500 units $\times 80\%$), the company is break-even.
- ✓ These figures are consistent with both the equation and the formula methods.



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 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 dollars?

- a. \$1,300
- b. \$1,715**

$$\begin{aligned} \text{BE sales \$} &= \frac{\text{Fixed Expense}}{\text{Contribution Margin}} \times \text{Current sales \$} \\ &= \frac{\$1,300}{(\$1.49 - \$0.36) \times 2,100} \times (2,100 \times \$1.49) \\ &= \$1,715 \end{aligned}$$

$$\begin{aligned} \text{Break-even sales \$} &= \frac{\text{Fixed expenses}}{\text{CM Ratio}} \\ &= \frac{\$1,300}{(1.49-0.36)/1.49} \\ &= \$1,715 \end{aligned}$$

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 units?

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



$$\text{BE sales} = \frac{\text{Fixed Expense}}{\text{Contribution Margin}} \times \text{Current sales}$$

Quick Check

Coffee Klatch is located in a local office building. The 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.

What is the break-even point?

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

$$= \frac{\$1,300}{(\$1.49 - \$0.36) \times 2,100} \times 2,100$$
$$= 1,150 \text{ cups}$$

$$\text{Break-even} = \frac{\text{Fixed expenses}}{\text{CM per Unit}}$$

$$= \frac{\$1,300}{\$1.49/\text{cup} - \$0.36/\text{cup}}$$

$$= \frac{\$1,300}{\$1.13/\text{cup}}$$

$$= 1,150 \text{ cups}$$

Learning Objective 6

Determine the level of sales needed to attain a target profit.



Target Profit Analysis

We can use any of the following methods to do target profit analysis:

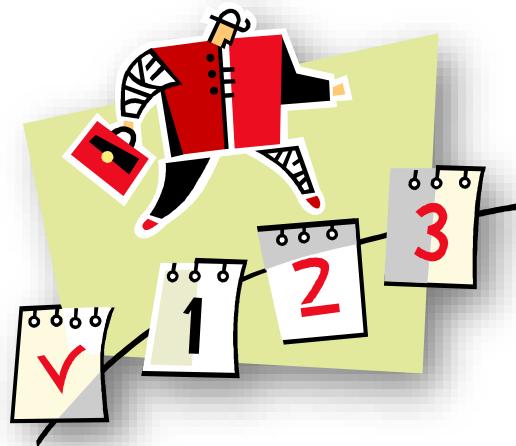
1. Equation method
2. Formula method
3. Percentage method



Target Profit Analysis: Equation Method for the Quantity required

Profit = Unit CM × Q – Fixed expenses

Our goal is to solve for the unknown “Q” which represents the quantity of units that must be sold to attain the target profit.





Target Profit Analysis:

Equation Method for the **Quantity** required

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

Profit = Unit CM × Q – Fixed expenses

$$\$100,000 = \$200 \times \text{Q} - \$80,000$$

$$\$200 \times \text{Q} = \$100,000 - \$80,000$$

$$\text{Q} = (\$100,000 + \$80,000) \div \$200$$

$$\text{Q} = 900$$





Target Profit Analysis:

The Formula Method for the **Quantity** required

The formula uses the following equation.

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





Target Profit Analysis:

The Formula Method for the **Quantity** required

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

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

$$\text{Unit sales} = \frac{\$100,000 + \$80,000}{\$200}$$

$$\text{Unit sales} = 900$$





Target Profit Analysis:

Equation Method for the **Sales \$** required

Profit = CM ratio × Sales – Fixed expenses

Our goal is to solve for the unknown “Sales” which represents the dollar amount of sales that must be sold to attain the target profit.

Suppose RBC management wants to know the sales volume that must be generated to earn a target profit of \$100,000.

$$\$100,000 = 40\% \times \text{Sales} - \$80,000$$

$$40\% \times \text{Sales} = \$100,000 + \$80,000$$

$$\text{Sales} = (\$100,000 + \$80,000) \div 40\%$$

$$\text{Sales} = \$450,000$$





Target Profit Analysis:

Formula Method for the **Sales \$** required

- We can calculate the dollar sales needed to attain a target profit (net operating profit) of \$100,000 at Racing Bicycle.

Dollar sales to attain the target profit = $\frac{\text{Target profit} + \text{Fixed expenses}}{\text{CM ratio}}$

$$\text{Dollar sales} = \frac{\$100,000 + \$80,000}{40\%}$$

$$\text{Dollar sales} = \$450,000$$





Target Profit Analysis: The Percentage Method

Modifying the BE% formula to add target profit to FE

$$\text{Target Profit\%} = \frac{\text{FE} + \text{Target Profit}}{\text{CM}} \times 100\%$$

$$\text{Target Profit\%} = \frac{\$80,000 + \$100,000}{\$100,000} \times 100\% = 180\%$$

- ✓ This means that the company requires 180% of its current sales in order to obtain the target profit.
- ✓ Currently, the company's sales are \$250,000 or 500 units.
- ✓ A Target Profit % of 180% means if the company sales are \$450,000 ($\$250,000 \times 180\%$) or 900 units ($500 \text{ units} \times 180\%$), the company has a target profit of \$100,000.
- ✓ These figures are consistent with both the equation and the formula methods.

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. Use the *formula method* to determine 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



Targeted sales = $\frac{\text{Fixed Expense} + \text{Targeted Profit}}{\text{Contribution Margin}} \times \text{Current sales}$

Quick

$$= \frac{\$1,300 + \$2,500}{(\$1.49 - \$0.36) \times 2,100} \times 2,100$$

$$= 3,363 \text{ cups}$$

\$1.49 and the average variable expense per cup is

\$0.36. Then

Use the formula
coffee would

\$2,500 per

a. 3,363

b. 2,212

c. 1,150

d. 4,200

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

$$= \frac{\$2,500 + \$1,300}{\$1.49 - \$0.36}$$

$$= \frac{\$3,800}{\$1.13}$$

$$= 3,363 \text{ cups}$$



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 and the average variable expense per cup is \$0.36. The average fixed expense per month is \$1,300. Use the *formula method* to determine the **sales dollars** that must be generated to attain target profits of \$2,500 per month.

- a. \$2,550
- b. \$5,011
- c. \$8,458
- d. \$10,555



Targeted sales \$ = $\frac{\text{Fixed Expense} + \text{Targeted Profit}}{\text{Contribution Margin}} \times \text{Current sales \$}$

Quick

Coffee
build

$$= \frac{\$1,300 + \$2,500}{(\$1.49 - \$0.36) \times 2,100} \times (2,100 \times \$1.49)$$
$$= \$5,011$$

\$1.49 and the average variable expense per cup is \$0.36. The average fixed expense per month is \$1,300.

Use the formula that must be met per month to attain target profit

- a. \$2,550
- b. \$5,011
- c. \$8,458
- d. \$10,555

$$\text{Sales \$ to attain target profit} = \frac{\text{Target profit} + \text{Fixed expenses}}{\text{CM ratio}}$$
$$= \frac{\$2,500 + \$1,300}{(\$1.49 - 0.36) \div \$1.49}$$
$$= \frac{\$3,800}{0.758}$$
$$= \$5,011$$

Learning Objective 7

Compute the margin of safety and explain its significance.





The Margin of Safety in Dollars

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

Margin of safety in dollars = Total sales - Break-even sales

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





The Margin of Safety in Dollars

If we assume that RBC 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	120,000	150,000
Contribution margin	80,000	100,000
Less: fixed expenses	80,000	80,000
Net operating income	<u><u>\$ -</u></u>	<u><u>\$ 20,000</u></u>



The Margin of Safety Percentage

RBC's 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 RBC is \$50,000, and each bike sells for \$500; hence, RBC's margin of safety is 100 bikes.

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



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 expressed in cups?

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

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



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

Linking Margin of Safety % (to sales) and Break-even % (to sales)

Margin of safety in dollars = Total sales - Break-even sales

$$\frac{\text{Margin of safety in dollars}}{\text{Total sales in dollars}} = \text{Margin of safety percentage (MoS%)}$$

$$= \frac{\text{Total sales} - \text{Breakeven sales}}{\text{Total sales}}$$

$$= 1 - \frac{\text{Breakeven in dollars}}{\text{Total sales in dollars}}$$

$$= 1 - \text{Breakeven percentage}$$

$$= 1 - \text{BE\%}$$

Therefore: $\text{BE\%} = 1 - \text{MoS \%}$



Breakeven Calculation

RBC's margin of safety = **20%** of sales

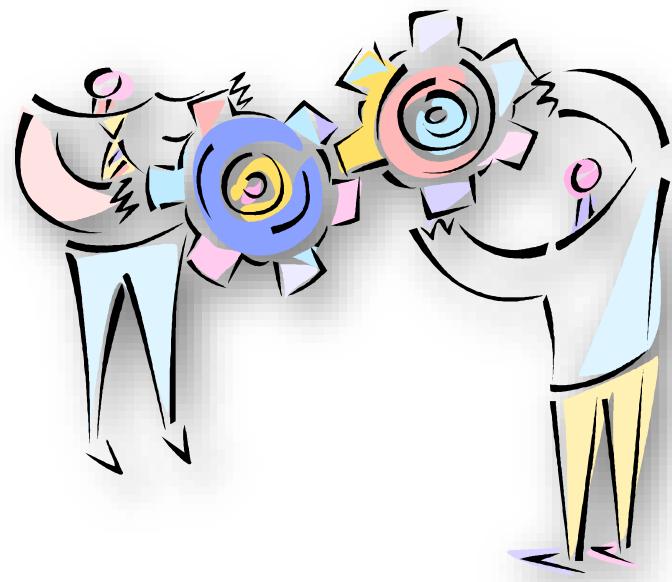
	Actual sales
	500 units
Sales	\$ 250,000
Less: variable expenses	150,000
Contribution margin	100,000
Less: fixed expenses	80,000
Net operating income	\$ 20,000

Break-even sales of RBC = $1 - 20\% = 80\%$ of sales
= $\$250,000 \times 80\%$
= $\$200,000$
= Break-even Sales on slide 75

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.

Companies with low fixed cost structures enjoy greater stability in income across good and bad years.



Learning Objective 8

Compute the degree of operating leverage at a particular level of sales and explain how it can be used to predict changes in net operating income.



Operating Leverage

Operating leverage is a measure of how sensitive net operating income is to percentage changes in sales. It is a measure, at any given level of sales, of how a percentage change in sales volume will affect profits.

$$DOL = \text{Degree of Operating Leverage} = \frac{\text{Contribution Margin}}{\text{Net Operating Income}^{**}}$$

** Profit Before Tax is a commonly used alternative to Net Operating Income in the degree of operating leverage calculation





Operating Leverage

To illustrate, let's revisit the contribution income statement for RBC.

	Actual sales
	500 Bikes
Sales	\$ 250,000
Less: variable expenses	150,000
Contribution margin	100,000
Less: fixed expenses	80,000
Net income	\$ 20,000

$$\begin{array}{lcl} \text{Degree of} \\ \text{Operating} \\ \text{Leverage} & = & \frac{\$100,000}{\$20,000} \\ & & = 5 \end{array}$$





Operating Leverage

With an operating leverage of **5**, if RBC increases its sales by **10%**, net operating income would increase by **50%**.

Percent increase in sales	10%
Degree of operating leverage	x 5
Percent increase in profits	50%



Here's the verification!

Operating Leverage

	Actual sales (500)	Increased sales (550)
Sales	\$ 250,000	\$ 275,000
Less variable expenses	150,000	165,000
Contribution margin	100,000	110,000
Less fixed expenses	80,000	80,000
Net operating income	\$ 20,000	\$ 30,000

10% increase in sales from
\$250,000 to \$275,000 . . .

. . . results in a 50% increase in
income from \$20,000 to \$30,000.



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 operating leverage?

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



Quick Check ✓

Coffee Klatch is an established coffee shop located in a downtown office building. The selling price of a cup of coffee is \$3.129. The variable expense per cup is \$1.300. The fixed expense per month is \$1,073. If 2,100 cups of coffee are sold each month, what is the company's operating leverage?

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

	<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>


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

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%



What does higher value of Operating Leverage mean?

- ▶ **High Operating Leverage ratio**
 - ▶ signals the existence of high fixed costs.
 - ▶ increases risk of making loss in adverse market conditions.
 - ▶ increases opportunity to make profit when higher demand exists.
 - ▶ has lower margin of safety percentage (MoS%)

$$DOL \approx \frac{1}{MoS\%}$$



Proof of Operating Leverage and Profit Movement Relationship

	Benchmark Co.	High F.C. Co.
Total Sales (Same)	\$3,200,000	\$3,200,000
Unit selling price (Same)	\$800	\$800
Unit variable costs	(\$300)	(\$150)
Unit Contribution margin	\$500	\$650
Unit sales (Same)	4,000	4,000
Contribution margin (CM)	\$2,000,000	\$2,600,000
Fixed costs	(\$1,500,000)	(\$2,100,000)
Net Operating Profit (Same) (P)	500,000	500,000
Degree of operating leverage (CM/P)	4.0	5.2



Proof of Operating Leverage and Profit Movement Relationship

	Benchmark Co.	High F.C. Co.
Increase in sales	12.5%	12.5%
Degree of operating leverage	X 4.0	X 5.2
Increase in profits	50%	65%
Proof:		
Unit contribution margin	\$500	\$650
Unit change in sales ($4,000 \times 12.5\%$)	x 500	x 500
Change in profits	\$250,000	\$325,000
Percentage increase from the original \$500,000 profit	50%	65%



Proof of Operating Leverage and MoS% Relationship

		Benchmark Co.	High F.C. Co.
Total Sales (Same)	(S)	\$3,200,000	\$3,200,000
Contribution margin	(CM)	\$2,000,000	\$2,600,000
Fixed costs	(F)	(\$1,500,000)	(\$2,100,000)
Net Operating Profit (Same)	(P)	500,000	500,000
Degree of operating leverage (CM/P)		4.0	5.2
Break-even Sales Dollars [F/(CM/S)]		2,400,000	2,584,615
Break-even % (to sales)		75%	80.77%
MoS% = 1 – BE% (see slide 77)		25%	19.23%
1/MoS%		4.0	5.2
= Degree of operating leverage			



Structuring Sales Commissions

Companies generally compensate salespeople by paying them either a commission based on sales or a salary plus a sales commission.

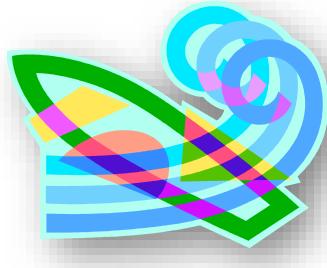
Commissions based on sales dollars can lead to *lower profits* in a company.

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.



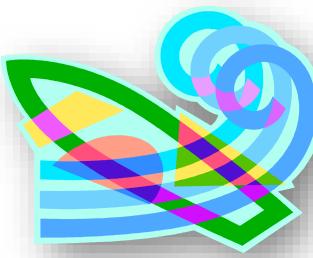
The sales force at Pipeline Unlimited is compensated based on sales commissions.



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.



Learning Objective 9

Compute the break-even point for a multiproduct company and explain the effects of shifts in the sales mix on contribution margin and the break-even point.





The Concept of Sales Mix

- ▶ Sales mix is the relative proportion in which a company's products are sold.
- ▶ Different products have different selling prices, cost structures, and contribution margins.
- ▶ When a company sells more than one product, break-even analysis becomes more complex as the following example illustrates.

Let's assume Racing Bicycle Company sells bikes and carts and that the sales mix between the two products remains the same.



Multi-Product Breakeven Analysis

(The BE% Method)

RBC's Bikes and Carts sales and profit data are as follows:

	Bicycle	Carts	Total
Sales	\$ 250,000	\$ 300,000	\$ 550,000
Variable expenses	150,000	135,000	285,000
Contribution margin	<u>100,000</u>	<u>165,000</u>	265,000
Fixed expenses			170,000
Net operating income			<u>\$ 95,000</u>

$$\text{Sales} \quad \$ 250,000 \quad \times \quad \$ 300,000$$

x

$$\text{BE\%} = 64.15\%$$

$$\text{Breakeven sales} \quad \$160,375 \quad \quad \quad \$192,450$$

Total break-even sales = \$352,825

$$\text{DOL} = \frac{\text{Contribution Margin}}{\text{Net Operating Income}} = \frac{1}{\text{MoS\%}}$$

$$\Rightarrow \text{MoS\%} = \frac{\text{Net Operating Income}}{\text{Contribution Margin}}$$

$$\Rightarrow \text{MoS\%} = \frac{95,000}{265,000} = 35.85\%$$

$$\therefore \text{MoS\%} = 1 - \text{BE\%}$$

$$\therefore \text{BE\%} = 1 - \text{MoS\%} = 1 - 35.85 = 64.15\%$$



Multi-Product Breakeven Analysis (The BE% Method)

	Bicycle		Carts		Total	
Sales	\$ 160,375	100%	\$ 192,450	100%	\$ 352,825	100.0%
Variable expenses	96,225	60%	86,603	45%	182,828	51.8%
Contribution margin	64,150	40%	105,847	55%	169,997	48.2%
Fixed expenses					170,000	
Net operating income			Rounding error		\$ (3)	



Multi-Product Breakeven Analysis (The CM Ratio Method)

Bikes comprise 45% of RBC's total sales revenue and the carts comprise the remaining 55%. RBC provides the following information:

	Bicycle		Carts		Total	
Sales	\$ 250,000	100%	\$ 300,000	100%	\$ 550,000	100.0%
Variable expenses	150,000	60%	135,000	45%	285,000	51.8%
Contribution margin	100,000	40.0%	165,000	55%	265,000	48.2%
Fixed expenses					170,000	
Net operating income					\$ 95,000	
Sales mix	\$ 250,000	45%	\$ 300,000	55%	\$ 550,000	100%

$$\frac{\$265,000}{\$550,000} = 48.2\% \text{ (rounded)}$$



Multi-Product Breakeven Analysis (The CM Ratio Method)

$$\text{Dollar sales to break even} = \frac{\text{Fixed expenses}}{\text{CM ratio}}$$

$$\text{Dollar sales to break even} = \frac{\$170,000}{48.2\%} = \$352,697$$

	Bicycle		Carts		Total	
Sales	\$ 158,714	100%	\$ 193,983	100%	\$ 352,697	100.0%
Variable expenses	95,228	60%	87,293	45%	182,521	51.8%
Contribution margin	<u>63,485</u>	<u>40%</u>	<u>106,691</u>	<u>55%</u>	<u>170,176</u>	<u>48.2%</u>
Fixed expenses					170,000	
Net operating income			Rounding error →		<u>\$ 176</u>	

Sales Mix \$ 158,714 45% \$ 193,983 55% \$ 352,697 100.0%



Compare the Breakeven Results calculated by the BE% and CM ratio methods

	Bicycle			Carts			Total	Rounding difference from the breakeven
Breakeven Sales Mix								
The BE% method	\$ 160,375	45%	\$ 192,450	55%	\$ 352,825	100%	\$	3
The CM ratio method	\$ 158,714	45%	\$ 193,983	55%	\$ 352,697	100%	\$	176

Using different methods to calculate the break-even points will result in slightly different answers due to rounding differences at different points of the calculations. In this example, the BE% seems to provide a better estimation.



Key Assumptions of CVP Analysis

- ① Selling price is constant.
- ② Costs are linear and can be accurately divided into variable (constant per unit) and fixed (constant in total) elements.
- ③ In multiproduct companies, the sales mix is constant.
- ④ In manufacturing companies, inventories do not change (units produced = units sold).



End of Chapter 4

