


# Cost-Volume-Profit Relationships

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Chapter Six



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## Learning Objective 1

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

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## Basics of Cost-Volume-Profit Analysis




	A	E	C	D	E	F
1	Racing Bicycle Company					
2	Contribution Income Statement					
3	For the Month of June					
4	Sales (500 bicycles) \$ 250,000					
5	Less: Variable expenses 150,000					
6	Contribution margin 100,000					
7	Less: Fixed expenses 80,000					
8	Net income \$ 20,000					

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

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## Basics of Cost-Volume-Profit Analysis



	A	E	C	D	E	F
1	Racing Bicycle Company					
2	Contribution Income Statement					
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6	Contribution margin 100,000					
7	Less: Fixed expenses 80,000					
8	Net income \$ 20,000					

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

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### 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.

	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 income	\$ 20,000	

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### The Contribution Approach

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

	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 income	\$ 20,000	

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### The Contribution Approach

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

	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 income	\$ -	

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### The Contribution Approach

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

	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 income	\$ 200	


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### 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 income will be \$6,000.



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### Learning Objective 2

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


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### 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

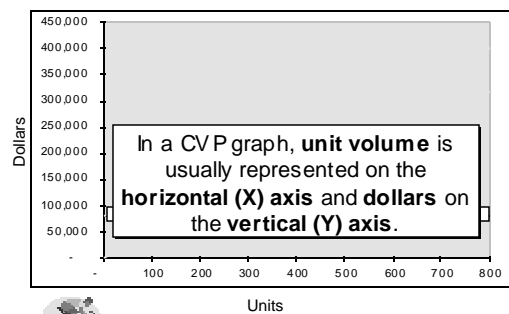


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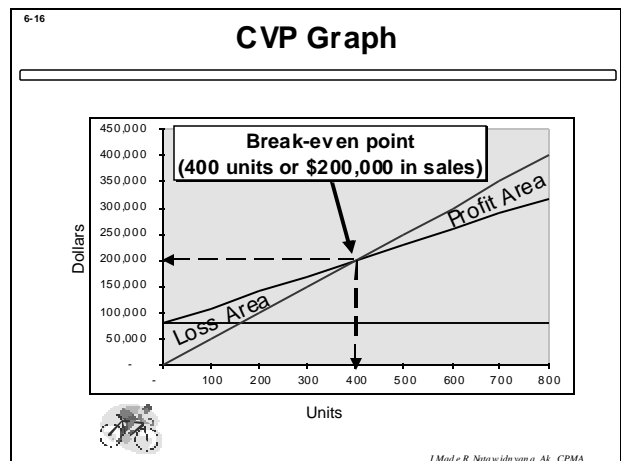
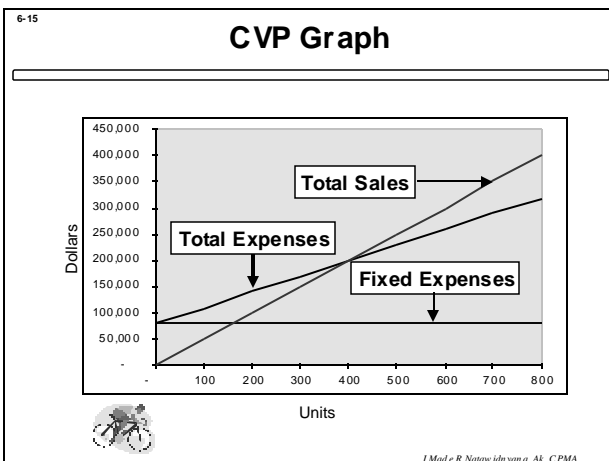
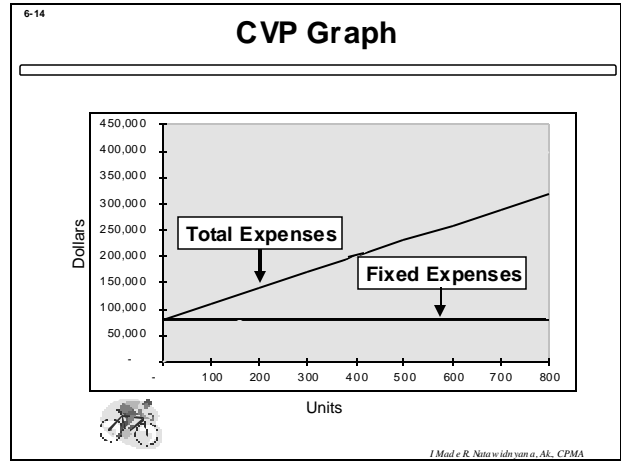
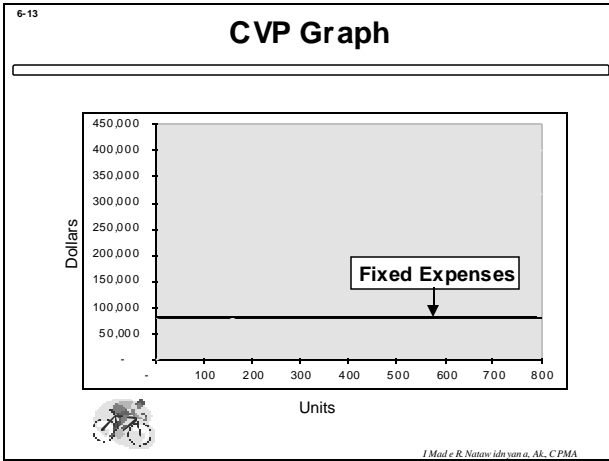
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### CVP Graph

In a CVP graph, **unit volume** is usually represented on the **horizontal (X) axis** and **dollars** on the **vertical (Y) axis**.



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### 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.

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### 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¢.



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### 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:

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


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### 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 × 40% = \$20,000)

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### Learning Objective 4

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

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### 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?

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### Changes in Fixed Costs and Sales Volume

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

	Current Sales (500 bikes)	Projected Sales (540 bikes)
Sales revenue	\$ 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 income	\$ 20,000	\$ 18,000

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

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### 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>\$ (2,000)</u>

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6-25 **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?



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6-26 **Change in Variable Costs and Sales Volume**

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

	Current Sales (500 bikes)	Projected Sales (580 bikes)
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.**

6-27 **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?



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6-28 **Change in Fixed Cost, Sales Price and Volume**

	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.**

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### Change in Variable Cost, Fixed Cost and Sales Volume

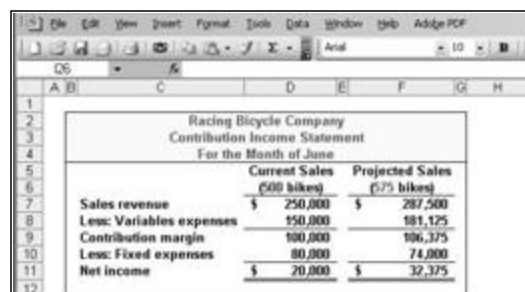
What is the profit impact if Racing (1) pays a \$15 sales commission per bike sold instead of paying salespersons flat salaries that currently total \$6,000 per month, and (2) increases unit sales from 500 to 575 bikes?



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### Change in Variable Cost, Fixed Cost and Sales Volume



	Current Sales (500 bikes)	Projected Sales (575 bikes)
Sales revenue	\$ 250,000	\$ 287,500
Less: Variable expenses	150,000	181,125
Contribution margin	100,000	106,375
Less: Fixed expenses	80,000	74,000
Net income	\$ 20,000	\$ 32,375


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

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### 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?



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### Change in Regular Sales Price

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


Variable cost per bike = 300 per bike

Selling price required = \$ 320 per bike

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

Total variable costs = 45,000

Increase in net income = \$ 3,000



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### Learning Objective 5

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


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### Break-Even Analysis

Break-even analysis can be approached in two ways:

1. Equation method
2. Contribution margin method



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
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### Equation Method

**Profits = (Sales – Variable expenses) – Fixed expenses**

OR

**Sales = Variable expenses + Fixed expenses + Profits**

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



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### 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	<u>150,000</u>	<u>300</u>	<u>60%</u>
Contribution margin	\$ 100,000	\$ 200	40%
Less: fixed expenses	<u>80,000</u>		
Net operating income	<u>\$ 20,000</u>		



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### Equation Method

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We calculate the break-even point as follows:

$$\text{Sales} = \text{Variable expenses} + \text{Fixed expenses} + \text{Profits}$$

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

Where:

- Q = Number of bikes sold
- \$500 = Unit selling price
- \$300 = Unit variable expense
- \$80,000 = Total fixed expense



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### Equation Method

---


We calculate the break-even point as follows:

$$\text{Sales} = \text{Variable expenses} + \text{Fixed expenses} + \text{Profits}$$

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

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

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

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


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### Equation Method

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

$$\text{Sales} = \text{Variable expenses} + \text{Fixed expenses} + \text{Profits}$$

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

Where:

- X = Total sales dollars
- 0.60 = Variable expenses as a % of sales
- \$80,000 = Total fixed expenses



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### Equation Method

---


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

$$\text{Sales} = \text{Variable expenses} + \text{Fixed expenses} + \text{Profits}$$

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

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

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

$$X = \$200,000$$


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### Contribution Margin Method

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The contribution margin method has two key equations.

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

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


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### Contribution Margin Method

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

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

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




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### Learning Objective 6

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



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### Target Profit Analysis

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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.



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### The CVP Equation Method

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**Sales = Variable expenses + Fixed expenses + Profits**

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

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

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


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### The Contribution Margin Approach

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

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

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



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### Learning Objective 7

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Compute the margin of safety and explain its significance.



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### The Margin of Safety





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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.



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### The Margin of Safety

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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	120,000	150,000
Contribution margin	80,000	100,000
Less: fixed expenses	80,000	80,000
Net operating income	\$ -	\$ 20,000

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### The Margin of Safety

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The margin of safety can be expressed as **20%** of sales.  
(\$50,000 ÷ \$250,000)

	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	\$ -	\$ 20,000

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### The Margin of Safety

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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.

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




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### Cost Structure and Profit Stability

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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.



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### 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.

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### 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.

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### Operating Leverage

A measure of how sensitive net operating income is to percentage changes in sales.

$$\text{Degree of operating leverage} = \frac{\text{Contribution margin}}{\text{Net operating income}}$$

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### Operating Leverage

At Racing, the degree of operating leverage is 5.

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

$$\frac{\$100,000}{\$20,000} = 5$$

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### Operating Leverage

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With an operating leverage of 5, if Racing 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	<u>50%</u>

Here's the verification!

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### Operating Leverage

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	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	<u>\$ 20,000</u>	<u>\$ 30,000</u>

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

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

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### Verify Increase in Profit

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

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### Structuring Sales Commissions

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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.

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### Structuring Sales Commissions

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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.



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### Structuring Sales Commissions

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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.



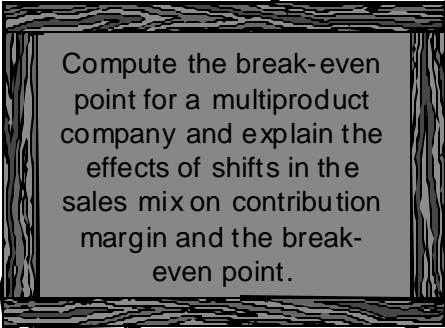
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### Learning Objective 9

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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.



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### The Concept of Sales Mix

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- 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.

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



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6-65 **Multi-product break-even analysis**

Racing Bicycle Co. provides the following information:

	Bicycles	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%	\$ 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%

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

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6-66 **Multi-product break-even analysis**

Break-even sales =  $\frac{\text{Fixed expenses}}{\text{CM Ratio}}$

=  $\frac{\$170,000}{48.2\%}$


= \$352,697

	Bicycles	Carts	Total
Sales	\$ 158,714 100%	\$ 193,983 100%	\$ 352,697 100.0%
Variable expenses	95,270 60%	87,292 45%	182,521 51.8%
Contribution margin	\$ 63,486 40%	\$ 106,691 55%	170,176 48.2%
Fixed expenses			170,000
Net operating income		Rounding error →	\$ 176
Sales mix	\$ 158,714 45%	\$ 193,983 55%	\$ 352,697 100%

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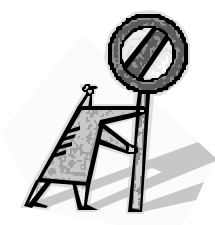
6-67 **Key Assumptions of CVP Analysis**

- ☒ Selling price is constant.
- Costs are linear.
- ☒ In multiproduct companies, the sales mix is constant.
- In manufacturing companies, inventories do not change (units produced = units sold).



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6-68 **End of Chapter 6**



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