Cost-Volume-Profit Relationships

Chapter 5

PowerPoint Authors:
Susan Coomer Galbreath, Ph.D., CPA
Charles W. Caldwell, D.B.A., CMA
Jon A. Booker, Ph.D., CPA, CIA
Cynthia J. Rooney, Ph.D., CPA

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Learning Objective 1

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

<table>
<thead>
<tr>
<th>Racing Bicycle Company Contribution Income Statement For the Month of June</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (500 bicycles)</td>
</tr>
<tr>
<td>Less: Variable expenses</td>
</tr>
<tr>
<td>Contribution margin</td>
</tr>
<tr>
<td>Less: Fixed expenses</td>
</tr>
<tr>
<td>Net operating income</td>
</tr>
</tbody>
</table>

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

#### Contribution Income Statement

For the Month of June

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (500 bicycles)</td>
<td>$250,000</td>
</tr>
<tr>
<td>Less: Variable expenses</td>
<td>150,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>100,000</td>
</tr>
<tr>
<td>Less: Fixed expenses</td>
<td>80,000</td>
</tr>
<tr>
<td>Net operating income</td>
<td>$20,000</td>
</tr>
</tbody>
</table>

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 |
|-------------------------------------------------|------------------|------------------|
| Sales (500 bicycles)                            | $ 250,000        | $ 500            |
| Less: Variable expenses                         | 150,000          | 300              |
| Contribution margin                             | 100,000          |                  |
| Less: Fixed expenses                            | 80,000           |                  |
| Net operating income                            | $ 20,000         |                  |
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).

<table>
<thead>
<tr>
<th>Racing Bicycle Company</th>
<th>Contribution Income Statement</th>
<th>For the Month of June</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>Per Unit</strong></td>
</tr>
<tr>
<td>Sales (500 bicycles)</td>
<td>$250,000</td>
<td>$500</td>
</tr>
<tr>
<td>Less: Variable expenses</td>
<td>$150,000</td>
<td>$300</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$100,000</td>
<td>$200</td>
</tr>
<tr>
<td>Less: Fixed expenses</td>
<td>$80,000</td>
<td></td>
</tr>
<tr>
<td>Net operating income</td>
<td>$20,000</td>
<td></td>
</tr>
</tbody>
</table>
The Contribution Approach

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

<table>
<thead>
<tr>
<th>Racing Bicycle Company Contribution Income Statement For the Month of June</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
</tr>
<tr>
<td>Sales (400 bicycles)</td>
</tr>
<tr>
<td>Less: Variable expenses</td>
</tr>
<tr>
<td>Contribution margin</td>
</tr>
<tr>
<td>Less: Fixed expenses</td>
</tr>
<tr>
<td>Net operating income</td>
</tr>
</tbody>
</table>
The Contribution Approach

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

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Per Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (401 bicycles)</td>
<td>$200,500</td>
<td>$500</td>
</tr>
<tr>
<td>Less: Variable expenses</td>
<td>120,300</td>
<td>$300</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>80,200</td>
<td>$200</td>
</tr>
<tr>
<td>Less: Fixed expenses</td>
<td>80,000</td>
<td></td>
</tr>
<tr>
<td>Net operating income</td>
<td>$200</td>
<td></td>
</tr>
</tbody>
</table>
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.
The contribution format income statement can be expressed in the following equation:

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

$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.

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

\[
\text{Quantity sold (Q)} \times \text{Selling price per unit (P)} = \text{Sales (Q} \times \text{P)}
\]

\[
\text{Quantity sold (Q)} \times \text{Variable expenses per unit (V)} = \text{Variable expenses (Q} \times \text{V)}
\]

\[
\text{Profit} = (P \times Q - V \times Q) - \text{Fixed expenses}
\]
CVP Relationships in Equation Form

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

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

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

\[
$200 = ($500 \times 401 - $300 \times 401) - $80,000
\]
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 × Q – V × Q) – Fixed expenses
Profit = (P – V) × Q – Fixed expenses
Profit = Unit CM × Q – Fixed expenses
CVP Relationships in Equation Form

Profit = (P × Q – V × Q) – Fixed expenses
Profit = (P – V) × Q – Fixed expenses
Profit = Unit CM × Q – Fixed expenses

Profit = ($500 – $300) × 401 – $80,000
Profit = $200 × 401 – $80,000
Profit = $80,200 – $80,000
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.

<table>
<thead>
<tr>
<th></th>
<th>Units Sold</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Sales</td>
<td>$</td>
</tr>
<tr>
<td>Total variable expenses</td>
<td>-</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>-</td>
</tr>
<tr>
<td>Fixed expenses</td>
<td>80,000</td>
</tr>
<tr>
<td>Net operating income (loss)</td>
<td>$ (80,000)</td>
</tr>
</tbody>
</table>
In a CVP graph, unit volume is usually represented on the horizontal (X) axis and dollars on the vertical (Y) axis.
Preparing the CVP Graph

1. Draw a line parallel to the volume axis to represent total fixed expenses.
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

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

Break-even point
(400 units or $200,000 in sales)

[Graph showing the break-even point at 400 units or $200,000 in sales]
Preparing the CVP Graph

An even simpler form of the CVP graph is called the profit graph.

\[ \text{Profit} = \text{Unit CM} \times Q - \text{Fixed Costs} \]
Preparing the CVP Graph

Break-even point, where profit is zero, is 400 units sold.
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.

<table>
<thead>
<tr>
<th>Racing Bicycle Company</th>
<th>Contribution Income Statement</th>
<th>For the Month of June</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Per Unit</td>
</tr>
<tr>
<td>Sales (500 bicycles)</td>
<td>$250,000</td>
<td>$500</td>
</tr>
<tr>
<td>Less: Variable expenses</td>
<td>150,000</td>
<td>300</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>100,000</td>
<td>$200</td>
</tr>
<tr>
<td>Less: Fixed expenses</td>
<td>80,000</td>
<td></td>
</tr>
<tr>
<td>Net operating income</td>
<td>$20,000</td>
<td></td>
</tr>
</tbody>
</table>

$100,000 ÷ $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 from 400 to 500 bikes ($50,000), contribution margin will increase by $20,000 ($50,000 × 40%). Here is the proof:

<table>
<thead>
<tr>
<th></th>
<th>400 Units</th>
<th>500 Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>$200,000</td>
<td>$250,000</td>
</tr>
<tr>
<td>Less: variable expenses</td>
<td>120,000</td>
<td>150,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>80,000</td>
<td>100,000</td>
</tr>
<tr>
<td>Less: fixed expenses</td>
<td>80,000</td>
<td>80,000</td>
</tr>
<tr>
<td>Net operating income</td>
<td>$ -</td>
<td>$20,000</td>
</tr>
</tbody>
</table>

A $50,000 increase in sales revenue results in a $20,000 increase in CM ($50,000 × 40% = $20,000).
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. An average of 2,100 cups are sold each month. What is the CM Ratio for Coffee Klatch?

a. 1.319  
b. 0.758  
c. 0.242  
d. 4.139
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. An average of 2,100 cups are sold each month. What is the CM Ratio for Coffee Klatch?

\[
\text{Unit contribution margin} = \frac{(\text{Unit selling price} - \text{Variable expense per cup})}{\text{Unit selling price}}
\]

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

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

Quick Check ✓

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

The correct answer is b. 0.758.
Contribution Margin Ratio (CM Ratio)

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

Profit = (CM ratio × Sales) – Fixed expenses

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

Profit = (40% × $250,000) – $80,000
Profit = $100,000 – $80,000
Profit = $20,000
Learning Objective 4

Show the effect on net operating income 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.

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Per Unit</th>
<th>CM Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (500 bicycles)</td>
<td>$250,000</td>
<td>$500</td>
<td>100%</td>
</tr>
<tr>
<td>Less: Variable expenses</td>
<td>150,000</td>
<td>300</td>
<td>60%</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>100,000</td>
<td>$200</td>
<td>40%</td>
</tr>
<tr>
<td>Less: Fixed expenses</td>
<td>80,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net operating income</td>
<td>$20,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th></th>
<th>500 units</th>
<th>540 units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>$250,000</td>
<td>$270,000</td>
</tr>
<tr>
<td>Less: Variable expenses</td>
<td>150,000</td>
<td>162,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>100,000</td>
<td>108,000</td>
</tr>
<tr>
<td>Less: Fixed expenses</td>
<td>80,000</td>
<td>90,000</td>
</tr>
<tr>
<td>Net operating income</td>
<td>$20,000</td>
<td>$18,000</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase in CM (40 units X $200)</td>
<td>$8,000</td>
</tr>
<tr>
<td>Increase in advertising expenses</td>
<td>$10,000</td>
</tr>
<tr>
<td>Decrease in net operating income</td>
<td>$(2,000)</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th></th>
<th>500 units</th>
<th>580 units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>$250,000</td>
<td>$290,000</td>
</tr>
<tr>
<td>Less: Variable expenses</td>
<td>150,000</td>
<td>179,800</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>100,000</td>
<td>110,200</td>
</tr>
<tr>
<td>Less: Fixed expenses</td>
<td>80,000</td>
<td>80,000</td>
</tr>
<tr>
<td>Net operating income</td>
<td>$20,000</td>
<td>$30,200</td>
</tr>
</tbody>
</table>

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 $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

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

<table>
<thead>
<tr>
<th></th>
<th>500 units</th>
<th>650 units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sales</strong></td>
<td>$ 250,000</td>
<td>$ 312,000</td>
</tr>
<tr>
<td><strong>Less: Variable expenses</strong></td>
<td>150,000</td>
<td>195,000</td>
</tr>
<tr>
<td><strong>Contribution margin</strong></td>
<td>100,000</td>
<td>117,000</td>
</tr>
<tr>
<td><strong>Less: Fixed expenses</strong></td>
<td>80,000</td>
<td>95,000</td>
</tr>
<tr>
<td><strong>Net operating income</strong></td>
<td>$ 20,000</td>
<td>$ 22,000</td>
</tr>
</tbody>
</table>

650 units \( \times \) $480 = $312,000
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

Sales increase by $37,500, fixed expenses decrease by $6,000, and net operating income increases by $12,375.

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

575 units × $315 = $181,125
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

\[
\begin{align*}
\$3,000 \div 150 \text{ bikes} &= \$20 \text{ per bike} \\
\text{Variable cost per bike} &= \underline{300} \text{ per bike} \\
\text{Selling price required} &= \underline{\$320} \text{ per bike}
\end{align*}
\]

\[
\begin{align*}
150 \text{ bikes} \times \$320 \text{ per bike} &= \$48,000 \\
\text{Total variable costs} &= \underline{45,000} \\
\text{Increase in net operating income} &= \underline{\$3,000}
\end{align*}
\]
Learning Objective 5

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

We can compute the number of units that must be sold to attain a target profit using either:

(1) Equation method, or
(2) Formula method.
Equation Method

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

Suppose RBC’s 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 × Q – $80,000

$200 × Q = $100,000 – $80,000

Q = ($100,000 + $80,000) ÷ $200

Q = 900
The Formula Method

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 in Terms of Unit Sales

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

\[
\text{Unit sales} = \frac{\text{Target profit} + \text{Fixed expenses}}{\text{CM per unit}}
\]

Unit sales = \( \frac{$100,000 + $80,000}{\$200} \) = 900
Target Profit Analysis

We can also compute the target profit in terms of sales dollars using either the equation method or the formula method.
Equation Method

**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% × Sales – $80,000

40% × Sales = $100,000 + $80,000

Sales = ($100,000 + $80,000) ÷ 40%

Sales = $450,000
Formula Method

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

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

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

Dollar sales = $450,000
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. 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
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?

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

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

\[
= \frac{3,800}{1.13}
\]

\[= 3,363 \text{ cups}\]

Quick Check ✓

a. 3,363 cups
b. 2,212 cups
c. 1,150 cups
d. 4,200 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. $5,013  
c. $8,458  
d. $10,555
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.

\[
\text{Sales$ to attain target profit} = \frac{\text{Target profit} + \text{Fixed expenses}}{\text{CM ratio}}
\]

\[
= \frac{\$2,500 + \$1,300}{($1.49 - 0.36) ÷ $1.49}
\]

\[
= \frac{\$3,800}{0.758}
\]

\[
= \$5,013
\]

a. $2,550
b. $5,013
c. $8,458
d. $10,555

Quick Check ✓
Learning Objective 6

Determine the break-even point.
Break-even Analysis

The equation and formula methods can be used to determine the unit sales and dollar sales needed to achieve a target profit of zero. Let’s use the RBC information to complete the break-even analysis.

<table>
<thead>
<tr>
<th>Racing Bicycle Company</th>
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<th>For the Month of June</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Per Unit</td>
</tr>
<tr>
<td>Sales (500 bicycles)</td>
<td>$ 250,000</td>
<td>$ 500</td>
</tr>
<tr>
<td>Less: Variable expenses</td>
<td>150,000</td>
<td>300</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>100,000</td>
<td>$ 200</td>
</tr>
<tr>
<td>Less: Fixed expenses</td>
<td>80,000</td>
<td></td>
</tr>
<tr>
<td>Net operating income</td>
<td>$ 20,000</td>
<td></td>
</tr>
</tbody>
</table>
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 a target profit of $0).

$0 = $200 × 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 × Q + $80,000

$200 × Q = $80,000

Q = 400 bikes
Break-even in Unit Sales: Formula Method

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

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

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

Unit sales = 400
Break-even in Dollar Sales: Equation Method

Suppose Racing Bicycle wants to compute the sales dollars required to break-even (earn a target profit of $0). Let’s use the equation method to solve this problem.

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

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

Sales = $80,000 ÷ 40\%

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.

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

Dollar sales = \( \frac{\$80,000}{40\%} \) = \$200,000
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. An average of 2,100 cups are sold each month. What is the break-even sales dollars?

a. $1,300  
b. $1,715  
c. $1,788  
d. $3,129
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. An average of 2,100 cups are sold each month. What is the break-even sales dollars?

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

---

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

\[
\begin{align*}
\text{Fixed expenses} & = \$1,300 \\
\text{CM Ratio} & = 0.758 \\
\text{Break-even sales} & = \frac{\$1,300}{0.758} \\
& = \$1,715
\end{align*}
\]
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. An average of 2,100 cups are sold each month. 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 and the average variable expense per cup is $0.36. The average fixed expense per month is $1,300. An average of 2,100 cups are sold each month. What is the break-even sales in units?

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

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

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

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

\[ = 1,150 \text{ cups} \]
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.

\[
\text{Margin of safety in dollars} = \text{Total sales} - \text{Break-even sales}
\]

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.

<table>
<thead>
<tr>
<th></th>
<th>Break-even sales</th>
<th>Actual sales</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>400 units</td>
<td>500 units</td>
</tr>
<tr>
<td>Sales</td>
<td>$200,000</td>
<td>$250,000</td>
</tr>
<tr>
<td>Less: variable expenses</td>
<td>120,000</td>
<td>150,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>80,000</td>
<td>100,000</td>
</tr>
<tr>
<td>Less: fixed expenses</td>
<td>80,000</td>
<td>80,000</td>
</tr>
<tr>
<td>Net operating income</td>
<td>$ -</td>
<td>$20,000</td>
</tr>
</tbody>
</table>
The Margin of Safety Percentage

RBC’s margin of safety can be expressed as **20%** of sales.

\( \frac{$50,000}{250,000} \)

<table>
<thead>
<tr>
<th>Break-even sales</th>
<th>Actual sales</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>sales</strong></td>
<td><strong>sales</strong></td>
</tr>
<tr>
<td>400 units</td>
<td>500 units</td>
</tr>
<tr>
<td>Sales</td>
<td>$ 200,000</td>
</tr>
<tr>
<td>Less: variable expenses</td>
<td>120,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>80,000</td>
</tr>
<tr>
<td>Less: fixed expenses</td>
<td>80,000</td>
</tr>
<tr>
<td>Net operating income</td>
<td>$ -</td>
</tr>
</tbody>
</table>
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.

\[
\text{Margin of Safety in units} = \frac{\$50,000}{\$500} = 100 \text{ bikes}
\]
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. An average of 2,100 cups are sold each month. What is the margin of safety expressed in cups?

a. 3,250 cups  
b. 950 cups  
c. 1,150 cups  
d. 2,100 cups
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. An average of 2,100 cups are sold each month. What is the margin of safety expressed in cups?

a. 3,250 cups  

Quick Check ✔

Margin of safety = Total sales – Break-even sales
= 2,100 cups – 1,150 cups
= 950 cups
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.

\[
\text{Degree of operating leverage} = \frac{\text{Contribution margin}}{\text{Net operating income}}
\]
Operating Leverage

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

<table>
<thead>
<tr>
<th>Actual sales</th>
<th>500 Bikes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>$ 250,000</td>
</tr>
<tr>
<td>Less: variable expenses</td>
<td>150,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>100,000</td>
</tr>
<tr>
<td>Less: fixed expenses</td>
<td>80,000</td>
</tr>
<tr>
<td>Net income</td>
<td>$ 20,000</td>
</tr>
</tbody>
</table>

Degree of Operating Leverage = \( \frac{\$100,000}{\$20,000} = 5 \)
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  \( \times \)  
Degree of operating leverage 5  
Percent increase in profits 50%
Operating Leverage

<table>
<thead>
<tr>
<th></th>
<th>Actual sales (500)</th>
<th>Increased sales (550)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>$ 250,000</td>
<td>$ 275,000</td>
</tr>
<tr>
<td>Less variable expenses</td>
<td>150,000</td>
<td>165,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>100,000</td>
<td>110,000</td>
</tr>
<tr>
<td>Less fixed expenses</td>
<td>80,000</td>
<td>80,000</td>
</tr>
<tr>
<td>Net operating income</td>
<td>$ 20,000</td>
<td>$ 30,000</td>
</tr>
</tbody>
</table>

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. An average of 2,100 cups are sold each month. What is the operating leverage?

a. 2.21
b. 0.45
c. 0.34
d. 2.92
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. An average of 2,100 cups are sold each month. What is the operating leverage?

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

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%
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%
## Verify Increase in Profit

<table>
<thead>
<tr>
<th></th>
<th>Actual sales</th>
<th>Increased sales</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2,100 cups</td>
<td>2,520 cups</td>
</tr>
<tr>
<td>Sales</td>
<td>$ 3,129</td>
<td>$ 3,755</td>
</tr>
<tr>
<td>Less: Variable expenses</td>
<td>$ 756</td>
<td>$ 907</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$ 2,373</td>
<td>$ 2,848</td>
</tr>
<tr>
<td>Less: Fixed expenses</td>
<td>$ 1,300</td>
<td>$ 1,300</td>
</tr>
<tr>
<td>Net operating income</td>
<td>$ 1,073</td>
<td>$ 1,548</td>
</tr>
</tbody>
</table>

% 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.
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 Break-Even Analysis

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

<table>
<thead>
<tr>
<th></th>
<th>Bicycle</th>
<th>Carts</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>$250,000</td>
<td>$300,000</td>
<td>$550,000</td>
</tr>
<tr>
<td>Variable expenses</td>
<td>150,000</td>
<td>135,000</td>
<td>285,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>100,000</td>
<td>165,000</td>
<td>265,000</td>
</tr>
<tr>
<td>Fixed expenses</td>
<td></td>
<td></td>
<td>170,000</td>
</tr>
<tr>
<td>Net operating income</td>
<td></td>
<td></td>
<td>$95,000</td>
</tr>
<tr>
<td>Sales mix</td>
<td>45%</td>
<td>55%</td>
<td>100%</td>
</tr>
</tbody>
</table>

\[
\frac{265,000}{550,000} = 48.2\% \text{ (rounded)}
\]
Multi-Product Break-Even Analysis

Dollar sales to break even = Fixed expenses / CM ratio

Dollar sales to break even = $170,000 / 48.2% = $352,697

<table>
<thead>
<tr>
<th></th>
<th>Bicycle</th>
<th></th>
<th>Carts</th>
<th></th>
<th>Total</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>$158,714</td>
<td>100%</td>
<td>$193,983</td>
<td>100%</td>
<td>$352,697</td>
<td>100.0%</td>
</tr>
<tr>
<td>Variable expenses</td>
<td>95,228</td>
<td>60%</td>
<td>87,293</td>
<td>45%</td>
<td>182,521</td>
<td>51.8%</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>63,485</td>
<td>40%</td>
<td>106,691</td>
<td>55%</td>
<td>170,176</td>
<td>48.2%</td>
</tr>
<tr>
<td>Fixed expenses</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>170,000</td>
<td></td>
</tr>
<tr>
<td>Net operating income</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$176</td>
<td></td>
</tr>
<tr>
<td>Sales mix</td>
<td>$158,714</td>
<td>45%</td>
<td>$193,983</td>
<td>55%</td>
<td>$352,697</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Rounding error
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 5