CHAPTER 5

COST - VOLUME - PROFIT

Managerial Accounting, Fourth Edition
1. Distinguish between variable and fixed costs.

2. Explain the significance of the relevant range.

3. Explain the concept of mixed costs.

4. List the five components of cost-volume-profit analysis.

5. Indicate what contribution margin is and how it can be expressed.
6. Identify the three ways to determine the break-even point.

7. Give the formulas for determining sales required to earn target net income.

8. Define margin of safety, and give the formulas for computing it.
To manage any business, you must understand:

- How costs respond to changes in sales volume
- The effect of costs and revenues on profit

To understand cost-volume-profit (CVP), you must know how costs behave.
Cost-Volume-Profit

Cost Behavior Analysis
- Variable costs
- Fixed costs
- Relevant range
- Mixed costs
- Identifying variable and fixed costs

Cost-Volume-Profit Analysis
- Basic components
- CVP income statement
- Break-even analysis
- Target net income
- Margin of safety
Cost Behavior Analysis

- Cost Behavior Analysis is the study of how specific costs respond to changes in the level of business activity.

- Some costs change; others remain the same.

- A knowledge of cost behavior helps management plan operations and decide between alternative courses of action.

- Cost behavior analysis applies to all types of entities.

LO 1: Distinguish between variable and fixed costs.
Starting point in cost behavior analysis is measuring key business activities.

Activity levels may be expressed in terms of:

- **Sales dollars** (in a retail company)
- **Miles driven** (in a trucking company)
- **Room occupancy** (in a hotel)
- **Dance classes taught** (by a dance studio)

Many companies use more than one measurement base.

**LO 1:** Distinguish between variable and fixed costs.
For an activity level to be useful:

Changes in the level or volume of activity should be correlated with changes in costs

The activity level selected is called the activity or volume index

The activity index:

Identifies the activity that causes changes in the behavior of costs

Allows costs to be classified according to their response to changes in activity as either:

Variable Costs    Fixed Costs    Mixed Costs

LO 1: Distinguish between variable and fixed costs.
Variable Costs

Variable costs are costs that vary in total directly and proportionately with changes in the activity level.

Example: If the activity level increases 10 percent, total variable costs will increase 10 percent.

Example: If the activity level decreases by 25 percent, total variable costs will decrease by 25 percent.

Variable costs remain the same per unit at every level of activity.

LO 1: Distinguish between variable and fixed costs.
Damon Company manufactures radios that contain a $10 digital clock.

The activity index is the number of radios produced.

For each radio produced, the total cost of the clocks increases by $10:

If 2,000 radios are produced, the total cost of the clocks is $20,000 (2,000 × $10).

If 10,000 radios are produced, the total cost of the clocks is $100,000 (10,000 × $10).

LO 1: Distinguish between variable and fixed costs.
Variable Costs - Graphs

(a) Total Variable Costs
(Digital Clocks)

(b) Variable Costs per Unit
(Digital Clocks)

LO 1: Distinguish between variable and fixed costs.
Fixed Costs

- Fixed costs are costs that *remain the same in total* regardless of changes in the activity level.
- Fixed costs *per unit cost* vary *inversely* with activity:
  - As volume increases, unit cost declines, and vice versa

Examples include:
- Depreciation on buildings and equipment
- Property taxes
- Insurance
- Rent

LO 1: Distinguish between variable and fixed costs.
Damon Company leases its productive facilities at a cost of $10,000 per month.

Total fixed costs of the facilities remain constant at every level of activity - $10,000 per month.

Fixed costs on a per unit basis vary inversely with activity - as activity increases, unit cost declines and vice versa.

At 2,000 radios, the unit cost is $5 \ ($10,000 \div 2,000\ units)\)
At 10,000 radios, the unit cost is $1 \ ($10,000 \div 10,000\ units)\)

LO 1: Distinguish between variable and fixed costs.
LO 1: Distinguish between variable and fixed costs.
Variable costs are costs that:

a. Vary in total directly and proportionately with changes in the activity level.

b. Remain the same per unit at every activity level.

c. Neither of the above.

d. Both (a) and (b) above.

LO 1: Distinguish between variable and fixed costs.
Relevant Range

Throughout the range of possible levels of activity, a straight-line relationship usually does not exist for either variable costs or fixed costs.

The relationship between variable costs and changes in activity level is often curvilinear.

For fixed costs, the relationship is also nonlinear - some fixed costs will not change over the entire range of activities while other fixed costs may change.

LO 2: Explain the significance of the relevant range.
LO 2: Explain the significance of the relevant range.
Relevant Range

- Defined as the range of activity over which a company expects to operate during a year.
- Within this range, a straight-line relationship usually exists for both variable and fixed costs.

LO 2: Explain the significance of the relevant range.
The relevant range is:

a. The range of activity in which variable costs will be curvilinear.

b. The range of activity in which fixed costs will be curvilinear.

c. The range over which the company expects to operate during a year.

d. Usually from zero to 100% of operating capacity.
Costs that have **both** a variable cost element and a fixed cost element

Sometimes called **semivariable cost**

Change in total but not proportionately with changes in activity level

LO 3: Explain the concept of mixed costs.
For purposes of CVP analysis, mixed costs must be classified into their fixed and variable elements.

One approach to separate the costs is called the high-low method.

Uses the total costs incurred at the high and low levels of activity to classify mixed costs into fixed and variable components.

The difference in costs between the high and low levels represents variable costs, since only variable costs change as activity levels change.

LO 3: Explain the concept of mixed costs.
Mixed Costs: Steps in High-Low Method

- **STEP 1:** Determine *variable cost per unit* using the following formula:

  \[
  \frac{\text{Change in Total Costs}}{\text{High minus Low Activity Level}} = \text{Variable Cost per Unit}
  \]

- **STEP 2:** Determine the *fixed cost* by subtracting the total variable cost at *either* the high or the low activity level from the total cost at that level.

**LO 3:** Explain the concept of mixed costs.
**Mixed Costs: High-Low Method Example**

**Data for Metro Transit Company for 4 month period:**

<table>
<thead>
<tr>
<th>Month</th>
<th>Miles Driven</th>
<th>Total Cost</th>
<th>Month</th>
<th>Miles Driven</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>20,000</td>
<td>$30,000</td>
<td>March</td>
<td>35,000</td>
<td>$49,000</td>
</tr>
<tr>
<td>February</td>
<td>40,000</td>
<td>48,000</td>
<td>April</td>
<td>50,000</td>
<td>63,000</td>
</tr>
</tbody>
</table>

**High Level of Activity:** April $63,000 50,000 miles

**Low Level of Activity:** January $30,000 20,000 miles

**Difference:** $33,000 30,000 miles

**Step 1:** Using the formula, variable costs per unit are $33,000 ÷ 30,000 = $1.10 variable cost per mile

**LO 3:** Explain the concept of mixed costs.
Chapter 5

Mixed Costs: 
High-Low- Method Example

**Step 2:** Determine the fixed costs by subtracting total variable costs at either the high or low activity level from the total cost at that same level

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>METRO TRANSIT</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Activity Level</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>1</td>
<td>Total cost</td>
<td>$63,000</td>
<td>$30,000</td>
</tr>
<tr>
<td>2</td>
<td>Variable costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>50,000 × $1.10</td>
<td>55,000</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>20,000 × $1.10</td>
<td></td>
<td>22,000</td>
</tr>
<tr>
<td>5</td>
<td>Total fixed costs</td>
<td><strong>$8,000</strong></td>
<td><strong>$8,000</strong></td>
</tr>
</tbody>
</table>

LO 3: Explain the concept of mixed costs.
Mixed Costs: High-Low-Method Example

- Maintenance costs:
  $8,000 per month plus $1.10 per mile

- To determine maintenance costs at a particular activity level:
  1. multiply the activity level times the variable cost per unit
  2. then add that total to the fixed cost

**EXAMPLE:** If the activity level is 45,000 miles, the estimated maintenance costs would be $8,000 fixed costs and $49,500 variable ($1.10 X 45,000 miles) for a total of $57,500.

LO 3: Explain the concept of mixed costs.
Mixed costs consist of a:

a. Variable cost element and a fixed cost element.

b. Fixed cost element and a controllable cost element.

c. Relevant cost element and a controllable cost element.

d. Variable cost element and a relevant cost element.

LO 3: Explain the concept of mixed costs.
Cost-Volume-Profit Analysis

CVP Analysis - the study of the effects of changes in costs and volume on a company's profits

Important in profit planning

A critical factor in setting selling prices, determining product mix, and maximizing use of production facilities

LO 4: List the five components of cost-volume-profit analysis.
CVP analysis considers the interrelationships among five basic components:

- Volume or level of activity
- Unit selling prices
- Variable cost per unit
- Total fixed costs
- Sales mix

LO 4: List the five components of cost-volume-profit analysis.
Assumptions Underlying CVP Analysis

- Behavior of both costs and revenues is linear throughout the relevant range of the activity index.
- Costs can be classified accurately as either variable or fixed.
- Changes in activity are the only factors that affect costs.
- All units produced are sold.
- When more than one type of product is sold, the sales mix will remain constant.

LO 4: List the five components of cost-volume-profit analysis.
Let's Review

One of the following is NOT involved in CVP analysis. That factor is:

a. Sales mix.

b. Unit selling prices.

c. Fixed costs per unit.  

\[\text{\textcolor{red}{c.}}\] Fixed costs per unit.

d. Volume or level of activity.

LO 4: List the five components of cost-volume-profit analysis.
CVP Income Statement

- Classifies costs and expenses as fixed or variable
- Reports contribution margin in the body of the statement.

**Contribution margin** -
amount of revenue
remaining after
deducting all variable costs

- Reports the same net
income as a traditional income statement

- A statement for internal use only

LO 5: Indicate what contribution margin is and how it can be expressed.
Vargo Video Company produces a DVD player/recorder.

Relevant data for June 2008:

- Unit selling price of DVD player: $500
- Unit variable costs: $300
- Total monthly fixed costs: $200,000
- Units sold: 1,600

VARGO VIDEO COMPANY
CVP Income Statement
For the Month Ended June 30, 2008

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Per Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (1,600 DVD players)</td>
<td>$800,000</td>
<td>$500</td>
</tr>
<tr>
<td>Variable costs</td>
<td>480,000</td>
<td>300</td>
</tr>
<tr>
<td><strong>Contribution margin</strong></td>
<td><strong>320,000</strong></td>
<td><strong>200</strong></td>
</tr>
<tr>
<td>Fixed costs</td>
<td>200,000</td>
<td></td>
</tr>
<tr>
<td><strong>Net income</strong></td>
<td><strong>$120,000</strong></td>
<td></td>
</tr>
</tbody>
</table>

LO 5: Indicate what contribution margin is and how it can be expressed.
Contribution Margin Per Unit

- Contribution margin is the amount available to cover fixed costs and to contribute to income.
- The formula for contribution margin per unit and the computation of the contribution margin per unit for Vargo Video are:

<table>
<thead>
<tr>
<th>Unit Selling Price</th>
<th>Unit Variable Costs</th>
<th>Contribution Margin per Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$500</td>
<td>$300</td>
<td>$200</td>
</tr>
</tbody>
</table>

- Thus, for every DVD player sold, Vargo Company has $200 to cover fixed costs and contribute to net income.

LO 5: Indicate what contribution margin is and how it can be expressed.
Since Vargo Company has fixed costs of $200,000, it must sell 1,000 DVD players ($200,000 ÷ $200) before it can earn any net income.

Vargo's CVP income statement, assuming a zero net income is:

<table>
<thead>
<tr>
<th>VARGO VIDEO COMPANY</th>
<th>CVP Income Statement</th>
<th>For the Month Ended June 30, 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Per Unit</td>
</tr>
<tr>
<td>Sales (1,000 DVD players)</td>
<td>$500,000</td>
<td>$500</td>
</tr>
<tr>
<td>Variable costs</td>
<td>300,000</td>
<td>300</td>
</tr>
<tr>
<td><strong>Contribution margin</strong></td>
<td><strong>200,000</strong></td>
<td><strong>$200</strong></td>
</tr>
<tr>
<td>Fixed costs</td>
<td>200,000</td>
<td></td>
</tr>
<tr>
<td><strong>Net income</strong></td>
<td>$ 0</td>
<td></td>
</tr>
</tbody>
</table>

**LO 5:** Indicate what contribution margin is and how it can be expressed.
For every DVD player that Vargo sells above 1,000 units, net income increases by the amount of the contribution margin, $200.

Vargo’s CVP income statement, assuming 1001 units sold is:

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Per Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (1,001 DVD players)</td>
<td>$500,500</td>
<td>$500</td>
</tr>
<tr>
<td>Variable costs</td>
<td>300,300</td>
<td>300</td>
</tr>
<tr>
<td><strong>Contribution margin</strong></td>
<td><strong>200,200</strong></td>
<td><strong>$200</strong></td>
</tr>
<tr>
<td>Fixed costs</td>
<td>200,000</td>
<td></td>
</tr>
<tr>
<td><strong>Net income</strong></td>
<td><strong>$  200</strong></td>
<td></td>
</tr>
</tbody>
</table>
Contribution Margin Ratio

- Shows the percentage of each sales dollar available to apply toward fixed costs and profits

- The contribution margin ratio is the contribution margin per unit divided by the unit selling price. For Vargo Company, the computation is:

\[
\text{Contribution Margin Ratio} = \frac{\text{Contribution Margin per Unit}}{\text{Unit Selling Price}}
\]

\[
\frac{200}{500} = 40\%
\]

- In this case, the contribution margin ratio of 40% means that $0.40 of each sales dollar is available to apply to fixed costs and contribute to net income

LO 5: Indicate what contribution margin is and how it can be expressed.
As shown below, the contribution margin ratio helps to determine the effect of changes in sales on net income.

<table>
<thead>
<tr>
<th></th>
<th>No Change</th>
<th>With Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Per Unit</td>
</tr>
<tr>
<td>Sales</td>
<td>$500,000</td>
<td>$500</td>
</tr>
<tr>
<td>Variable costs</td>
<td>300,000</td>
<td>300</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>200,000</td>
<td>$200</td>
</tr>
<tr>
<td>Fixed costs</td>
<td>200,000</td>
<td></td>
</tr>
<tr>
<td>Net income</td>
<td>$ -0-</td>
<td></td>
</tr>
</tbody>
</table>
Contribution margin:

a. Is revenue remaining after deducting variable costs.

b. May be expressed as contribution margin per unit.

c. Is selling price less cost of goods sold.

d. Both (a) and (b) above.

LO 5: Indicate what contribution margin is and how it can be expressed.
A key relationship in CVP analysis is the level of activity at which total revenue equals total costs (both fixed and variable).

This level of activity is called the break-even point.

At this volume of sales, the company will realize no income, but will also suffer no loss.

Can be computed or derived:
- from a mathematical equation,
- by using contribution margin, or
- from a cost-volume profit (CVP) graph.

The break-even point can be expressed either in sales units or in sales dollars.

LO 6: Identify the three ways to determine the break-even point.
Break-Even Analysis: Mathematical Equation

- Break-even occurs where total sales equal variable costs plus fixed costs; i.e., net income is zero.

- The formula for the **break-even point in units** and the computation for Vargo Video are:

\[
\text{Sales} = \text{Variable Costs} + \text{Fixed Costs} + \text{Net Income}
\]

\[
\begin{align*}
$500Q & = $300Q + $200,000 + $0 \\
$200Q & = $200,000 \\
Q & = 1,000 \text{ units}
\end{align*}
\]

where

- \( Q \) = sales volume in units
- \$500 = selling price
- \$300 = variable cost per unit
- \$200,000 = total fixed costs

- To find **sales dollars** required to break-even:

\[
1,000 \text{ units} \times $500 = $500,000 \text{ (break-even sales dollars)}
\]

**LO 6:** Identify the three ways to determine the break-even point.
Break-Even Analysis: Contribution Margin Technique

- At the break-even point, contribution margin must equal total fixed costs
  
  \[ \text{(Contribution Margin} = \text{total revenues} - \text{variable costs}) \]

- The break-even point (BEP) can be computed using either contribution margin per unit or contribution margin ratio.

LO 6: Identify the three ways to determine the break-even point.
Contribution Margin Technique

When the contribution margin per unit is used, the formula to compute the BEP in units for Vargo Video is:

\[
\frac{\text{Fixed Costs}}{\text{Contribution Margin per Unit}} = \text{Break-even Point in Units}
\]

\[
\frac{\$200,000}{\$200} = 1,000 \text{ units}
\]

When the BEP in dollars is desired, contribution margin ratio is used in the following formula for Vargo Video:

\[
\frac{\text{Fixed Costs}}{\text{Contribution Margin Ratio}} = \text{Break-even Point in Dollars}
\]

\[
\frac{\$200,000}{40\%} = \$500,000
\]

LO 6: Identify the three ways to determine the break-even point.
Break-Even Analysis: Graphic Presentation

- A cost-volume profit (CVP) graph shows the relationships between costs, volume and profits.

- To construct a CVP graph:
  - Plot the total-sales line starting at the zero activity level
  - Plot the total fixed cost using a horizontal line
  - Plot the total-cost line (starts at the fixed-cost line at zero activity)
  - Determine the break-even point from the intersection of the total-cost line and the total-sales line

LO 6: Identify the three ways to determine the break-even point.
LO 6: Identify the three ways to determine the break-even point.
Gossen Company is planning to sell 200,000 pliers for $4 per unit. The contribution margin ratio is 25%. If Gossen will break even at this level of sales, what are the fixed costs?

a. $100,000.
b. $160,000.
c. $200,000.
d. $300,000.

LO 6: Identify the three ways to determine the break-even point.
Break-Even Analysis: Target Net Income

- Rather than just breaking even, management usually sets an income objective called “target net income”.
- Indicates sales or units necessary to achieve this specified level of income.
- Can be determined from each of the approaches used to determine break-even sales/units:
  - from a mathematical equation,
  - by using contribution margin, or
  - from a cost-volume profit (CVP) graph.
- Expressed either in sales units or in sales dollars.

LO 7: Give the formulas for determining sales required to earn target net income.
Break-Even Analysis: Target Net Income

Mathematical Equation

Using the basic formula for the break-even point, simply include the desired net income as a factor. The computation for Vargo Video is as follows:

\[
\text{Required Sales} = \text{Variable Costs} + \text{Fixed Costs} + \text{Target Net Income}
\]

\[
$500Q = $300Q + $200,000 + $120,000
\]

\[
$200Q = $320,000
\]

\[
Q = 1,600
\]

where

\[
Q = \text{sales volume}
\]

\[
$500 = \text{selling price}
\]

\[
$300 = \text{variable costs per unit}
\]

\[
$200,000 = \text{total fixed costs}
\]

\[
$120,000 = \text{target net income}
\]

LO 7: Give the formulas for determining sales required to earn target net income.
Contribution Margin Technique

To determine the required sales in units for Vargo Video:

\[
\frac{\text{Fixed Costs + Target Net Income}}{\text{Contribution Margin Per Unit}} = \frac{\$200,000 + \$120,000}{\$200} = 1,600 \text{ units}
\]

To determine the required sales in dollars for Vargo Video:

\[
\frac{\text{Fixed Costs + Target Net Income}}{\text{Contribution Margin Ratio}} = \frac{\$200,000 + \$120,000}{40\%} = \$800,000
\]

LO 7: Give the formulas for determining sales required to earn target net income.
The mathematical equation for computing required sales to obtain target net income is:

\[ \text{Required sales} = \? \]

a. Variable costs + Target net income.

b. Variable costs + Fixed costs + Target net income.

c. Fixed costs + Target net income.

d. No correct answer is given.

LO 7: Give the formulas for determining sales required to earn target net income.
Break-Even Analysis: Margin of Safety

- Difference between actual or expected sales and sales at the break-even point

- Measures the “cushion” that management has, allowing it to break-even even if expected sales fail to materialize

- May be expressed in dollars or as a ratio

To determine the margin of safety in dollars for Vargo Video assuming that actual/expected sales are $750,000:

<table>
<thead>
<tr>
<th>Actual (Expected) Sales</th>
<th>Break-even Sales</th>
<th>Margin of Safety in Dollars</th>
</tr>
</thead>
<tbody>
<tr>
<td>$750,000</td>
<td>$500,000</td>
<td>$250,000</td>
</tr>
</tbody>
</table>

LO 8: Define margin of safety, and give the formulas for computing it.
Margin of Safety Ratio

- Computed by dividing the margin of safety in dollars by the actual or expected sales.
- To determine the margin of safety ratio for Vargo Video assuming that actual/expected sales are $750,000:

  \[
  \text{Margin of Safety Ratio} = \frac{\text{Margin of Safety in Dollars}}{\text{Actual (Expected) Sales}}
  \]

  \[
  \begin{array}{ccc}
    \text{Margin of Safety in Dollars} & \div & \text{Actual (Expected) Sales} \\
    \$250,000 & \div & \$750,000 \\
    & & = 33\%
  \end{array}
  \]

- The higher the dollars or the percentage, the greater the margin of safety.

LO 8: Define margin of safety, and give the formulas for computing it.
Marshall Company had actual sales of $600,000 when break-even sales were $420,000. What is the margin of safety ratio?

a. 25%.

b. 30%.

c. 33 1/3%.

d. 45%.

LO 8: Define margin of safety, and give the formulas for computing it.
A Hybrid Dilemma

Hybrid vehicles typically cost $3,000 to $5,000 more than conventional vehicles.

The most fuel efficient hybrids can save about $660 per year in fuel costs.

Each gallon of gas not burned reduces carbon dioxide emissions by 19 pounds.
A Hybrid Dilemma

What do you think?

Do you think that making the investment in a hybrid car will slow the cash outflow from your wallet due to high gas prices and save your feet?

Because of the premium charged for hybrid cars, would you ever break-even on your investment?
Deines Company accumulates the following data concerning a mixed cost, using miles as the activity level.

<table>
<thead>
<tr>
<th>Miles Driven</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>$14,150</td>
</tr>
<tr>
<td>February</td>
<td>$13,600</td>
</tr>
<tr>
<td>March</td>
<td>$15,000</td>
</tr>
<tr>
<td>April</td>
<td>$14,490</td>
</tr>
</tbody>
</table>

*Compute the variable and fixed cost elements using the high-low method.*
High Level of Activity: March $15,000 8,500 miles
Low Level of Activity: February 13,600 7,500 miles
Difference $1,400 1,000 miles

Step 1:
Variable Cost per Unit = $1,400 \div 1,000 \text{ miles}
= $1.40 \text{ variable cost per mile}

Step 2:

Step 2:

<table>
<thead>
<tr>
<th></th>
<th>High</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Cost:</td>
<td>$15,000</td>
<td>$13,600</td>
</tr>
<tr>
<td>Variable Cost:</td>
<td>$11,900</td>
<td>$10,500</td>
</tr>
<tr>
<td>8,500 X $1.40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7,500 X $1.40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Fixed Costs</td>
<td>$3,100</td>
<td>$3,100</td>
</tr>
</tbody>
</table>