

## **CHAPTER 7 CLASS ADOBE CONNECT COST-VOLUME-PROFIT ANALYSIS**

### **I. Cost-Volume-Profit (CVP) Analysis**

- A. Break-even point
  - Contribution-margin approach
  - Contribution-margin ratio
  - Equation approach
- E. Graphing CVP relationships
- F. Adding target net profit to the break-even point

### **II. Assumptions Underlying CVP Analysis**

### **III. Applying CVP Analysis**

- A. Safety margin
- B. Sensitivity analysis. Changes in fixed expenses, variable expenses, selling prices, and volume

**IV. CVP Analysis with Multiple Products**

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- B. Uses weighted-average contribution margin

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- A. Traditional income statements
- B. Contribution income statements

**VI. Cost Structure and Operating Leverage****VII. CVP Analysis, Activity-Based Costing, and Advanced Manufacturing Systems**

## **COST-VOLUME-PROFIT (CVP) ANALYSIS**

CVP uses the knowledge of cost behavior discussed in previous chapters, especially Chapter 6. **CVP is used in decision making.**

**CVP analysis**, *examines the interrelationships of sales activity, prices, costs, and profits in planning and decision-making situations.*

**Key Concept.** An organization's costs are categorized into variable and fixed components before beginning the analysis.

### **BREAKEVEN**

A major use of CVP is to compute **Break Even**,

- The **volume at which the company will have zero profit**
- The **volume at which revenues = expenses.**

Sometimes, the term break-even analysis is used in place of CVP.

The Break-Even point can be computed in several ways.

**Breakeven can be computed in dollars or units.**

## ASSUMPTIONS UNDERLYING CVP ANALYSIS

- The **behavior of *total revenue* is linear within the relevant range.**
- The **behavior of *total expenses* is linear within the relevant range.**  
This assumption dictates that
  - (1) expenses can be categorized as fixed, variable, or semivariable and
  - (2) efficiency and productivity remain as predicted.
- The ***sales mix remains constant over the relevant range.***
- *Inventory levels at the beginning and end of the accounting period are the same.* This assumption implies that during the period, the number of units sold equals the number of units produced.

### Targeted Net Profit

- Adds a target net profit to break even

**Three approaches to computing break-even:**

- **contribution-margin approach**
  - **Dollars**
  - **Units**
- **equation approach**
- **graph approach**

**THE CONTRIBUTION-MARGIN APPROACH**

**Contribution Margin (in dollars)**

- **Contribution margin** per unit (in dollars) =
  - Selling price per unit- Variable expenses per unit

**Contribution Margin Ratio**

<b>Contribution Margin Ratio</b>	=	$\frac{\text{Contribution Margin per unit (1)}}{\text{Sales Price per unit}}$
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(1) Sales price per unit – variable costs per unit

***BREAK-EVEN VOLUME (UNITS)***

Based on the concept of the **contribution margin**, or the amount that each unit contributes toward covering fixed expenses and generating profit.

<b>Break-Even Volume (units)</b>	=	$\frac{\text{Fixed Costs}}{\text{Unit \$ Contribution Margin}}$
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***BREAK-EVEN IN DOLLARS***

1. Multiply the break-even point in units by the selling price.

OR

2. Use the **contribution margin ratio**

<b>Break-Even Volume (sales dollars)</b>	=	$\frac{\text{Fixed Costs}}{\text{Contribution Margin Ratio}}$
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**Example Problem. P7-40**

## **EQUATION APPROACH**

At the break-even point, sales revenues equal the sum of variable and fixed expenses since profit is zero.

$$\text{Sales} - \text{Total variable expenses} - \text{Total fixed expenses} = \text{ZERO.}$$

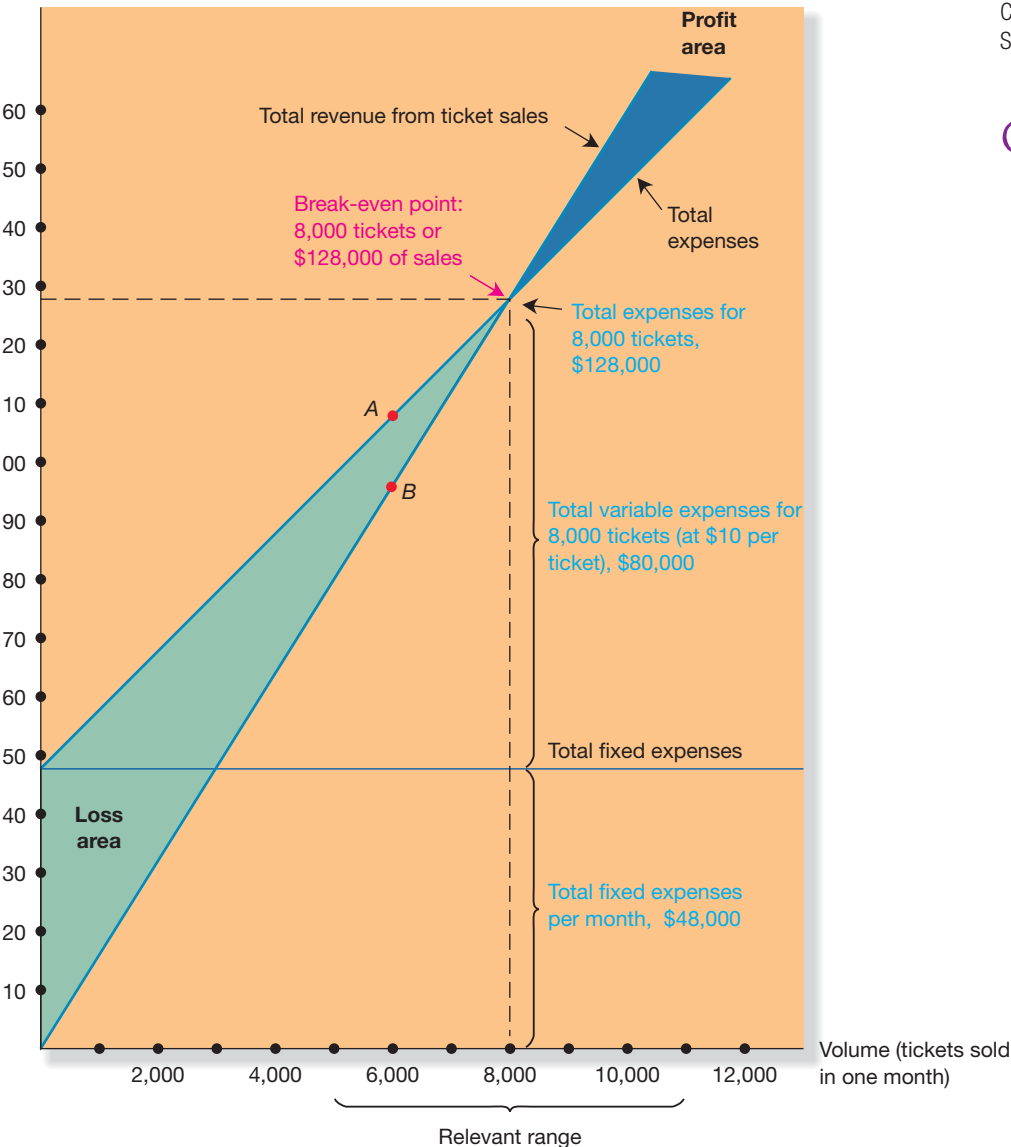
Therefore

$$\text{Break-even point (\$)} = \text{Total variable expenses} + \text{Total fixed expenses}$$

## **GRAPH APPROACH**

CVP relationships can be communicated in the form of a **cost-volume-profit graph** (see Exhibit 7-1 in the text).

000 (per month)

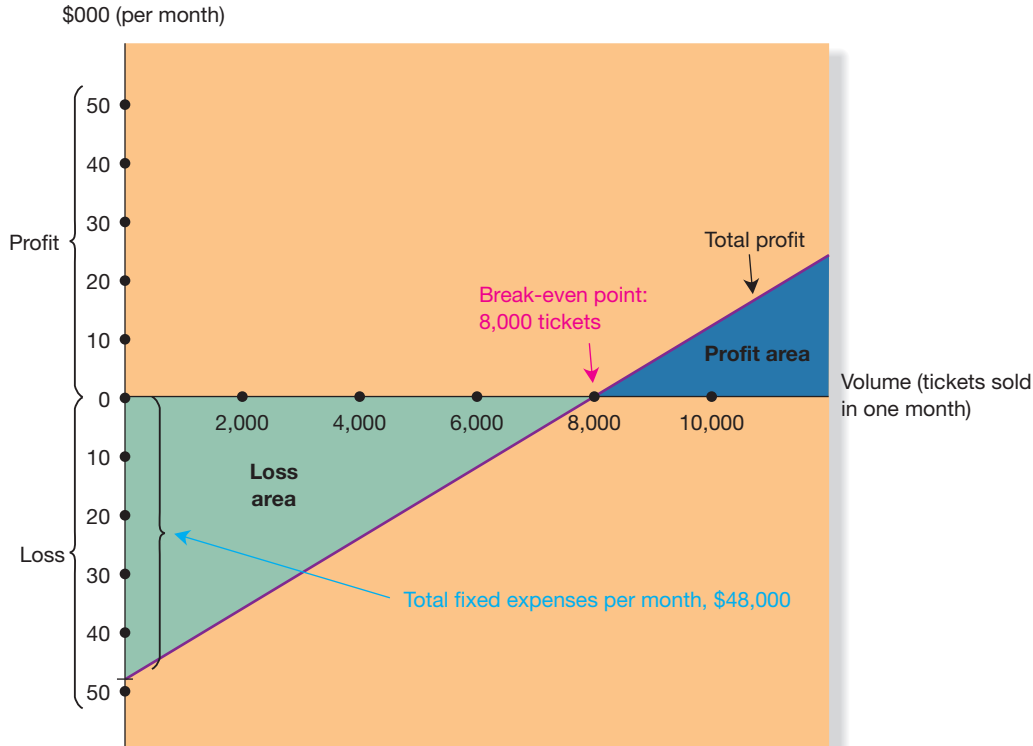


### Exhibit 7-1

Cost-Volume-Profit Graph:  
Seattle Contemporary Theater





**Exhibit 7-3**

Profit-Volume Graph: Seattle Contemporary Theater



## TARGET PROFIT

Break-even can be modified to determine the level of sales needed to produce a particular **target net profit**.

### *Contribution Margin Approach- Units*

Each unit now contributes toward covering fixed expenses *and* generating profit (some amount other than zero).

$$\text{Sales (units)} = (\text{Fixed expenses} + \text{Target net profit}) \div \underline{\text{Contribution margin per unit}}$$

<b>Target Profit (units)</b>	=	$\frac{\text{Fixed Costs} + \text{Target Profit}}{\text{Unit \$ Contribution Margin}}$
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### *Contribution Margin Approach-Sales Dollars*

$$\text{Sales (\$)} = (\text{Total fixed expenses} + \text{Target net profit}) \div \underline{\text{Contribution margin ratio}}$$

<b>Target Profit (sales dollars)</b>	=	$\frac{\text{Fixed Costs} + \text{Target Profit}}{\text{Contribution Margin Ratio}}$
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### *Equation Approach*

Sales dollars must now be large enough to cover variable expenses and fixed expenses, *and* produce a particular profit. Thus:

$$\text{Sales (\$)} = \text{Total variable expenses} + \text{Total fixed expenses} + \text{Target net profit}$$

**NOTE: Understanding CVP, Breakeven, and Target Profit are important takeaways in the course, and will be important in testing situations.**

## Safety Margin

- Shows the amount that sales can fall before a firm starts losing money, is computed as follows:

$$\text{Safety margin} = \text{Budgeted sales} - \text{Break-even sales}$$

- Note: **safety margin issued in planning**, and is an *ex ante* concept.

**Example:** If budgeted sales = \$17,000,000 and breakeven = \$14,500,000, then safety margin = \$2,500,000.

If contribution margin is \$50 per unit, then sales in units can fall by  $\$2,500,000 / \$50 = 50,000$  units before breakeven is reached.

## CVP ANALYSIS WITH MULTIPLE PRODUCTS

- Most organizations have more than one product line, and CVP analysis may be adapted for these firms.
- The same basic equations are used; however, the **contribution margin must be weighted by the sales mix**.
- The **sales mix** is the number of units sold of a given product relative to the total units sold.
- For example, if a company sells 8,000 units of product A and 2,000 units of product B, the sales mix is 80% A and 20% B.
- A **weighted-average unit contribution margin** is calculated by multiplying a product's contribution margin by its sales mix percentage, and then summing the results for individual products.
- The result is divided into fixed expenses to arrive at the break-even point in "units." *These "units" are really a commingled market basket of goods.*
- As a final step, the sales-mix percentages are multiplied by the number of "units" to calculate individual product sales to break even.

**Note: a change in a firm's sales mix will alter the break-even point.**

## COST STRUCTURE AND OPERATING LEVERAGE

- The **cost structure** of an organization is the *relative proportion of fixed and variable costs*.
- The extent to which an organization uses fixed costs in its cost structure is called **operating leverage**.
  - The higher the proportion of fixed costs, the higher the operating leverage
- A firm's cost structure has a significant effect on the way that profits fluctuate in response to changes in sales volume.
- **The greater the proportion of fixed costs, the greater the impact on profit from a given percentage change in sales revenue.**

- A company with a high proportion of fixed costs and a low proportion of variable costs has high operating leverage and the ability to greatly increase net income from an increase in sales revenue.
  - The operating risk is also greater because if the break-even point is not reached, losses will be larger in a high-leverage situation.
- The degree of operating leverage can be measured as follows:

<b>Operating leverage factor = Total contribution margin ÷ Net income</b>
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- **This factor, when multiplied by the percentage change in sales revenue, will equal the percentage change in net income.**

**Example. Textbook E7-31**

A contribution margin income statement for the Nantucket Inn is shown below (income taxes ignored).

Revenue	\$500,000
Less: variable expenses	<u>300,000</u>
Contribution Margin	200,000
Less: fixed expenses	<u>150,000</u>
Net income	\$50,000

1. Show the hotel's cost structure by indicating the percentage of the hotel's revenue represented by each item on the income statement.
2. Suppose the hotel's revenue declines by 15%. Use the contribution-margin percentage to calculate the resulting decrease in net income.
3. What is the hotel's operating leverage factor when revenue is \$500,000?
4. Use the operating leverage factor to calculate the increase in net income resulting from a 20% increase in sales revenue.



1

Revenue	\$500,000	100.0%
Less: variable expenses	<u>300,000</u>	<u>60.0%</u>
Contribution Margin	200,000	40.0%
Less: fixed expenses	<u>150,000</u>	<u>30.0%</u>
Net income	\$50,000	10.0%

2

Revenue (down 15%)	\$425,000	100.0%
Less: variable expenses	<u>255,000</u>	<u>60.0%</u>
Contribution Margin	170,000	40.0%
Less: fixed expenses	<u>150,000</u>	<u>35.3%</u>
Net income	\$20,000	4.7%

3. Operating leverage factor = contribution margin / net income

$$200,000 / 50,000 = 4.00$$

4. 20% increase in revenue yields what increase in net income?

20% increase in revenue = 4.00 operation leverage factor = 80% change in net income.

\$50,000 (net income at \$500,000 revenue) x .8 = \$40,000 increase in net income.

4. Check

Revenue (20% increase)	\$600,000	100.0%
Less: variable expenses	360,000	60.0%
Contribution Margin	240,000	40.0%
Less: fixed expenses	150,000	25.0%
Net income	\$90,000	15.0%

## EXERCISE 7-31

1. The following income statement, often called a *common-size income statement*, provides a convenient way to show the cost structure.

	Amount	Percent
Revenue .....	\$500,000	100
Variable expenses .....	<u>300,000</u>	<u>60</u>
Contribution margin .....	\$200,000	40
Fixed expenses .....	<u>150,000</u>	<u>30</u>
Net income .....	<u>\$ 50,000</u>	<u>10</u>

2.

Decrease in Revenue		Contribution Margin Percentage		Decrease in Net Income
\$75,000*	×	40%†	=	\$30,000

$$*\$75,000 = \$500,000 \times 15\%$$

$$†40\% = \$200,000 / \$500,000$$

3. Operating leverage factor (at revenue of \$500,000) =  $\frac{\text{contribution margin}}{\text{net income}}$
- $$= \frac{\$200,000}{\$50,000} = 4$$

4. Percentage change in net income =  $\left( \frac{\text{percentage increase}}{\text{in revenue}} \right) \times \left( \frac{\text{operating leverage}}{\text{factor}} \right)$
- $$= 20\% \times 4$$
- $$= 80\%$$

## **CVP ANALYSIS, ACTIVITY-BASED COSTING, AND ADVANCED MANUFACTURING SYSTEMS**

Cost behavior may change with a shift from a traditional-costing system to an ABC system.

The traditional CVP analysis recognizes a single, volume-based cost driver, namely, sales volume.

With the multiple drivers of ABC, some traditional fixed costs are now considered variable.

## CONTRIBUTION MARGIN INCOME STATEMENT

The text illustrates how the contribution margin version of the income statement is useful to management. See next page

Format:

	Sales
-	Variable expenses (including variable OH)
=	Contribution Margin
-	Fixed expenses
	Net Income

***Note: this format is not in accordance with GAAP.***

It is used for internal decision making purposes

**A. Traditional Format**

**ACCUTIME COMPANY**  
**Income Statement**  
**For the Year Ended December 31, 20x1**

Sales .....		\$500,000
Less: Cost of goods sold .....		<u>380,000</u>
Gross margin .....		\$120,000
Less: Operating expenses:		
Selling expenses .....	\$ 35,000	
Administrative expenses .....	<u>35,000</u>	<u>70,000</u>
Net income .....		<u><u>\$ 50,000</u></u>

**B. Contribution Format**

**ACCUTIME COMPANY**  
**Income Statement**  
**For the Year Ended December 31, 20x1**

Sales .....		\$500,000
Less: Variable expenses:		
Variable manufacturing .....	\$280,000	
Variable selling .....	15,000	
Variable administrative .....	<u>5,000</u>	<u>300,000</u>
Contribution margin .....		\$200,000
Less: Fixed expenses:		
Fixed manufacturing .....	\$100,000	
Fixed selling .....	20,000	
Fixed administrative .....	<u>30,000</u>	<u>150,000</u>
Net income .....		<u><u>\$ 50,000</u></u>

**Exhibit 7–5**

Income Statement: Traditional  
and Contribution Formats



Serendipity Sound, Inc. manufactures and sells compact discs. Price and cost data are as follows:

Selling price per unit (package of two CDs) .....	<u>\$25.00</u>
Variable costs per unit:	
Direct material .....	\$10.50
Direct labor .....	5.00
Manufacturing overhead .....	3.00
Selling expenses .....	<u>1.30</u>
Total variable costs per unit .....	<u>\$19.80</u>
Annual fixed costs:	
Manufacturing overhead .....	\$ 192,000
Selling and administrative .....	<u>276,000</u>
Total fixed costs .....	<u>\$ 468,000</u>
Forecasted annual sales volume (120,000 units) .....	\$ 3,000,000

In the following requirements, ignore income taxes.

**Required:**

1. What is Serendipity Sound's break-even point in units?
2. What is the company's break-even point in sales dollars?
3. How many units would Serendipity Sound have to sell in order to earn \$260,000?
4. What is the firm's margin of safety?
5. Management estimates that direct-labor costs will increase by 8 percent next year. How many units will the company have to sell next year to reach its break-even point?
6. If the company's direct-labor costs do increase by 8 percent, what selling price per unit of product must it charge to maintain the same contribution-margin ratio?

(CMA, adapted)

■ **Problem 7–40**

Basic CVP Relationships

**(LO 1, 2, 4)**

3. Sales units required for target net profit: 140,000 units

6. Old contribution-margin ratio: .208

Contribution margin	
\$25.00 - \$19.80	\$5.20
Contribution margin ratio	
\$5.20 / \$25.00	0.208



# **PROBLEM 7-40 ANSWER**

$$\begin{aligned}
 1. \quad \text{Break-even point (in units)} &= \frac{\text{fixed costs}}{\text{unit contribution margin}} \\
 &= \frac{\$468,000}{\$25.00 - \$19.80} = 90,000 \text{ units}
 \end{aligned}$$

$$\begin{aligned}
 2. \quad \text{Break-even point (in sales dollars)} &= \frac{\text{fixed cost}}{\text{contribution-margin ratio}} \\
 &= \frac{\$468,000}{\frac{\$25.00 - \$19.80}{\$25.00}} = \$2,250,000
 \end{aligned}$$

$$\begin{aligned}
 3. \quad \text{Number of sales units required to} &= \frac{\text{fixed costs} + \text{target net profit}}{\text{unit contribution margin}} \\
 \text{earn target net profit} &= \frac{\$468,000 + \$260,000}{\$25.00 - \$19.80} = 140,000 \text{ units}
 \end{aligned}$$

4. **Margin of safety** = budgeted sales revenue – break-even sales revenue  
 = (120,000)(\$25) – \$2,250,000 = \$750,000

5. **Break-even point if direct-labor costs increase by 8 percent:**

**New unit contribution margin** = \$25.00 – \$10.50 – (\$5.00)(1.08) – \$3.00 – \$1.30  
 = \$4.80

**Break-even point** = 
$$\frac{\text{fixed costs}}{\text{new unit contribution margin}}$$
  
 = 
$$\frac{\$468,000}{\$4.80} = 97,500 \text{ units}$$

$$6. \quad \text{Contribution margin ratio} = \frac{\text{unit contribution margin}}{\text{sales price}}$$

$$\begin{aligned} \text{Old contribution-margin ratio} &= \frac{\$25.00 - \$19.80}{\$25.00} \\ &= .208 \end{aligned}$$

Let  $P$  denote sales price required to maintain a contribution-margin ratio of .208. Then  $P$  is determined as follows:

$$\frac{P - \$10.50 - (\$5.00)(108) - \$3.00 - \$1.30}{P} = .208$$

$$P - \$20.20 = .208P$$

$$.792P = \$20.20$$

$$P = \$25.51(\text{rounded})$$

$$\begin{aligned} \text{Check: New contribution-} & \quad = \frac{\$25.51 - \$10.50 - (\$5.00)(108) - \$3.00 - \$1.30}{\$25.51} \\ \text{margin ratio} & \quad = .208(\text{rounded}) \end{aligned}$$