Cost-Volume-Profit Relationships

Chapter 6, part II

Learning Objective 6

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

Target Profit Analysis

In **target profit analysis**, we estimate what sales volume is needed to achieve a specific target profit.

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.

Target Profit Analysis – 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 – Equation Method Solution

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.

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

Target Profit Analysis – Formula Method Solution

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

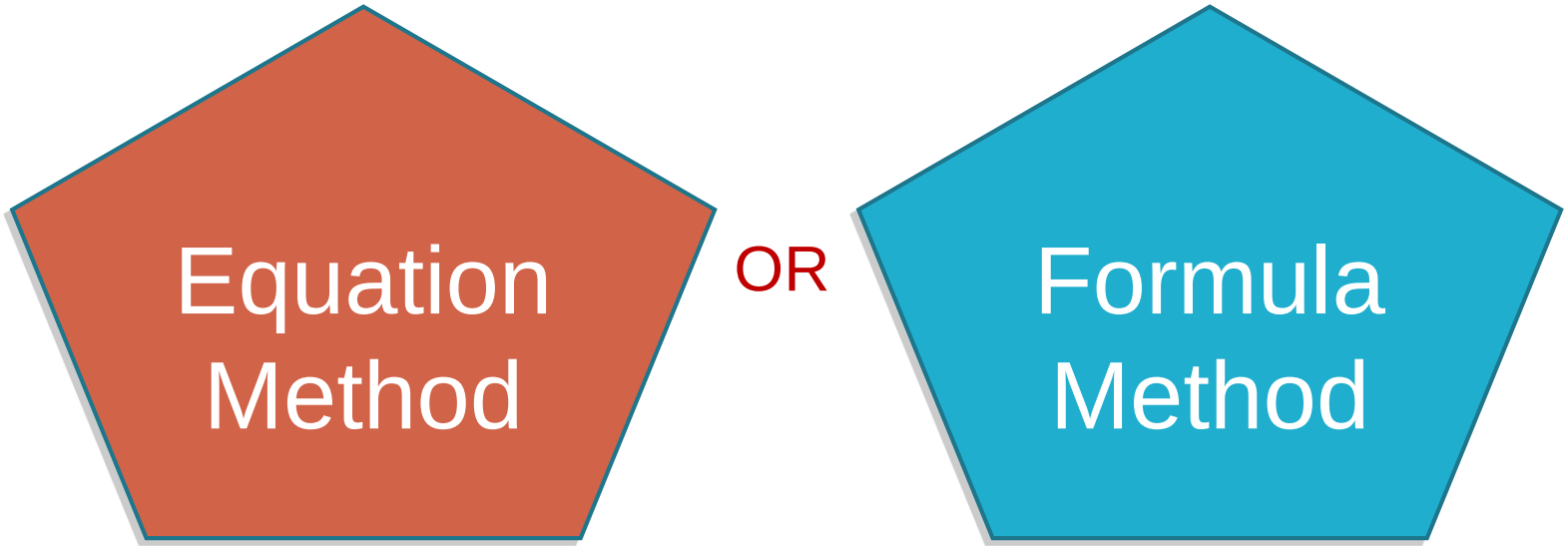
$$\text{Unit sales to attain the target profit} = \frac{\text{Target profit + Fixed expenses}}{\text{CM per unit}}$$

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

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

Target Profit Analysis – Formula Method Sales Dollars

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



Target Profit Analysis – Equation Method Sales Dollars Solution

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

Profit = CM ratio × Sales – Fixed expenses

$100,000 = 40% × Sales – $80,000
40% × Sales = $100,000 + $80,000
Sales = ($100,000 + $80,000) ÷ 40%
Sales = $450,000

Target Profit Analysis – Formula Method Sales Dollars Solution

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

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

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

Concept Check 4

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

Concept Check 4a

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 me*
would have
month.

a. 3,363 cu
b. 2,212 cu
c. 1,150 cu
d. 4,200 cu

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

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

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

= 3,363 cups

Concept Check 5

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

Concept Check 5a

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 me*
generated

a. $2,550

b. $5,013

c. $8,458

d. $10,555

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

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

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

$$= \$5{,}013$$

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 dollars. It is the amount by which sales can drop before losses are incurred. The higher the margin of safety, the lower the risk of not breaking even and incurring a loss.

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

Let's look at RBC and determine the margin of safety.

The Margin of Safety in Dollars – Example

If we assume that RBC has actual sales of $250,000, given that we have already determined the break-even sales to be $200,000, the margin of safety is $50,000 as shown.

	Break-even sales 400 units	Actual sales 500 units
Sales	$ 200,000	$ 250,000
Less: variable expenses	120,000	150,000
Contribution margin	80,000	100,000
Less: fixed expenses	80,000	80,000
Net operating income	$ -	$ 20,000

The Margin of Safety Percentage

RBC's 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

The Margin of Safety in Units

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.

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

Concept Check 6

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

Concept Check 6a

Coffee Klatch is an espresso stand in a downtown office building. The average selling price of a cup of coffee is $1.40 and the average variable expense per cup is $1. Coffee Klatch's monthly fixed expenses are $1,100. What is the margin of safety in cups?

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

a. 3,250 cups

b. 950 cups

c. 1,150 cups

d. 2,100 cups

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 - Example

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

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

$$\text{Degree of Operating Leverage} = \frac{\$100,000}{\$20,000} = 5$$

Operating Leverage – Changes in Profit

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

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

Here's the verification!

Operating Leverage – Proof of Changes

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

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

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

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 – High and Low Fixed Cost Structures (1/2)

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.

Cost Structure and Profit Stability – High and Low Fixed Cost Structures (2/2)

Companies with a **high fixed cost structure have higher operating leverage:** they must cover a larger amount of fixed costs, regardless of whether they sell any units of product	Companies with **low fixed cost structure have lower operating leverage**: they may have high costs that vary directly with their sales but have lower fixed costs to cover each month

The Operating leverage formula shows that companys' costs and profit relate to each other, and that *reducing fixed costs* can *increase profits without changing sales quantity, contribution margin or selling price*

Quick Check 7

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

Concept Check 7a

Coffee Klatch is an espr
office building. The aver
coffee is $1.49 and the
per cup is $0.36. The av
month is $1,300. An ave
each month. What is the

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

	Actual sales 2,100 cups
Sales	$ 3,129
Less: Variable expenses	756
Contribution margin	2,373
Less: Fixed expenses	1,300
Net operating income	$ 1,073

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

$$= \frac{\$2,373}{\$1,073} = 2.21$$

Concept Check 8

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%

Concept Check 8a

At Coffee Klatch the average selling price of a cup of coffee is $1.49, the average variable expense per cup is $0.36, the average fixed expense per month is $1,300, and an average of 2,100 cups are sold each month.

If sales increase by 20%, by how much should net operating income increase?

a. 30.0%

b. 20.0%

c. 22.1%

d. 44.2%

	Percent increase in sales	**20.0%**
×	**Degree of operating leverage**	**2.21**
	Percent increase in profit	**44.20%**

Concept Check 8a
Verify Increase in Profit

	Actual sales	*Increased sales*
	2,100 cups	*2,520 cups*
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	$ 1,073	$ 1,548
% change in sales		20.0%
% change in net operating income		44.2%

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 Definition 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 RBC sells bikes and carts and that the sales mix between the two products remains the same.

Sales Mix and Break-Even Analysis – Part 1

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

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

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

Sales Mix and Break-Even Analysis – Part 2

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

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

	Bicycle	Bicycle	Carts	Carts	Total	Total
Sales	$ 158,714	100%	$ 193,983	100%	$ 352,697	100.0%
Less: Variable expenses	95,228	60%	87,293	45%	182,521	51.8%
Contribution margin	63,486	40%	106,690	55%	170,176	48.2%
Fixed expenses					170,000	
Net operating income					$ 176	
Sales Mix	**$ 158,714**	**45%**	**$ 193,983**	**55%**	**$ 352,697**	**100.0%**

Rounding error - $176

RECAP

MAIN EQUATIONS&FORMULA (1/4)

Profit = (Sales – Variable expenses) – Fixed expenses

General equation

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

Profit = Unit CM × Q – Fixed expenses

Function of the CM

$$\textbf{CM Ratio} = \frac{\text{Contribution margin}}{\text{Sales}} \quad \text{OR} \quad \frac{\text{Contribution margin per unit}}{\text{Selling price per unit}}$$

$$\textbf{Variable expense ratio} = \frac{\text{Variable expenses}}{\text{Sales}}$$

CM Ratio = 1 – Variable expense ratio

Profit = (CM ratio x Sales) – Fixed expenses

Function of the CM ratio

MAIN EQUATIONS&FORMULA (2/4)

Profits = Unit CM × Q – Fixed expenses

$$\textbf{Unit sales to break even} = \frac{\text{Fixed expenses}}{\text{Units CM}}$$

How may units required to have profit 0=?

Profit = CM ratio × Sales – Fixed expenses

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

How may sales dollars required to have profit 0=?

MAIN EQUATIONS&FORMULA (3/4)

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

How many units must be sold to earn a target profit?

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

What is the sales volume that must be generated to earn a target profit?

MAIN EQUATIONS&FORMULA (4/4)

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

$$\textbf{Margin of Safety in units} = \frac{\text{Margin of safety in dollars}}{\text{Selling price per unit}}$$

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

Exercises

Allwill Products distributes a single product, a decorative plate whose selling price is $10 and whose variable cost is $6 per unit. The company's monthly fixed expense is $7,500.

***Required**:*

1. Calculate the company's break-even point in unit sales.
2. Calculate the company's break-even point in dollar sales.
3. If the company's fixed expenses increase by $500, what would become the new breakeven point in unit sales? In dollar sales?

[EX.01]

***Requirement 1**:* Compute the company's break-even point in unit sales.

Profit = Unit CM × Q − Fixed expenses

$0 = ($10 − $6) × Q − $7,500

$0 = $4 × Q − $7,500

$4 × Q = $7,500

Q = $7,500 ÷ $4

Q = 1,875 plates

***Requirement 2**:* Compute the company's break-even point in dollar sales.

Unit sales to break even 1,875

Selling price per unit $10

Dollar sales to break even $18,750

***Requirement 3**:* If the company's fixed expenses increase by $500, what would become the new breakeven point in unit sales? In dollar sales?

Profit = Unit CM × Q − Fixed expenses

$0 = ($10 − $6) × Q − $8,000

$0 = $4 × Q − $8,000

$4 × Q = $8,000

Q = $8,000 ÷ $4 **Q = 2,000 plates**

Unit sales to break even 2,000
Selling price per unit $10

Dollar sales to break even $20,000

Stepman Corporation has a single product whose selling price is $200 and whose variable expense is $150 per unit. The company's monthly fixed expense is $75,000.

***Required**:*

1. Calculate the unit sales needed to attain a target profit of $9,000.
2. Calculate the dollar sales needed to attain a target profit of $10,000.

[Ex.02]

***Requirement 1**:* Calculate the unit sales needed to attain a target profit of $9,000.

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

$$\$9{,}000 = (\$200 - \$150) \times Q - \$75{,}000$$

$$\$9{,}000 = (\$50) \times Q - \$75{,}000$$

$$\$50 \times Q = \$9{,}000 + \$75{,}000$$

$$Q = \$84{,}000 \div \$50$$

$$Q = 1{,}680 \text{ units}$$

***Requirement 2**:* Calculate the dollar sales needed to attain a target profit of $10,000.

Dollar sales to attain the target profit

$$= \frac{\text{Target profit} + \text{Fixed expenses}}{\text{Contribution margin ratio}}$$

$$= \frac{\$10{,}000 + \$75{,}000}{25\%}$$

$$= \frac{\$85{,}000}{25\%} = \$340{,}000$$

Shamrock Products markets two video games: Running and Skiing. A contribution format income statement for a recent month for the two games appears below:

	Running	Skiing	Total
Sales	$120,000	$40,000	$160,000
Variable expenses	55,000	17,000	72,000
Contribution margin	$ 65,000	$23,000	88,000
Fixed expenses			41,250
Net operating income			$ 46,750

Required:

1. Compute the overall contribution margin (CM) ratio for the company.
2. Compute the overall break-even point for the company in dollar sales .
3. Verify the overall break-even point for the company by constructing a contribution format
   income statement showing the appropriate levels of sales for the two products.

[Ex.03]

Requirement 1: Compute the overall contribution margin (CM) ratio for the company.

$$\text{Overall CM ratio} = \frac{\text{Total contribution margin}}{\text{Total sales}}$$

$$= \frac{\$88{,}000}{\$160{,}000} = 55\%$$

Requirement 2: Compute the overall break-even point for the company in sales dollars.

$$\text{Overall break - even} = \frac{\text{Total fixed expenses}}{\text{Overall CM ratio}}$$

$$= \frac{\$41{,}250}{55\%} = \$75{,}000$$

Requirement 3: Verify the overall break-even point for the company by constructing a contribution format income statement showing the appropriate levels of sales for the two products.

	Running	Skiing	Total
Original dollar sales	$120,000	$40,000	$160,000
Percent of total	75%	25%	100%
Sales at break-even	$ 56,250	$18,750	$ 75,000

	Running	Skiing	Total
Sales	$ 56,250	$18,750	$ 75,000
Variable expenses	25,781	7,969	33,750
Contribution margin	$ 30,469	$10,781	41,250
Fixed expenses			41,250
Net operating income			$ 0

Fill in the missing amounts in each of the four case situations below. Each case is independent of the others. (*Hint:* One way to find the missing amounts would be to prepare a contribution format income statement for each case, enter the known data, and then compute the missing items.)

Case	Units Sold	Sales	Variable Expenses	Contribution Margin per Unit	Fixed Expenses	Net Operating Income
A	20,000	$300,000	$220,000	?	$45,000	?
B	12,000	?	$120,000	$15	?	$18,000

Case	Sales	Variable Expenses	Average Contribution Margin Ratio	Fixed Expenses	Net Operating Income
C	$900,000	?	40%	?	$125,000
D	?	?	45%	$120,000	$37,500

Required:

1. Cases A and B assume that only one product is being sold.
2. Cases C and D assume that more than one product is being sold.

[Ex.04]

Requirement 1: Cases A and B assume that only one product is being sold.

	Case A	
Number of units sold	20,000	
Sales	$ 300,000	$ 15
Variable expenses	220,000	11
Contribution margin	80,000	$ 4
Fixed expenses	45,000	
Net operating income	$ 35,000	

	Case B	
Number of units sold	12,000	
Sales	$ 300,000	$ 25
Variable expenses	120,000	10
Contribution margin	180,000	$ 15
Fixed expenses	162,000	
Net operating income	$ 18,000	

Requirement 2: Cases C and D assume that more than one product is being sold.

	Case C	
Sales	$ 900,000	100%
Variable expenses	540,000	60%
Contribution margin	360,000	40%
Fixed expenses	235,000	
Net operating income	$ 125,000	

	Case D	
Sales	$ 350,000	100 %
Variable expenses	192,500	55%
Contribution margin	157,500	45%
Fixed expenses	120,000	
Net operating income	$ 37,500	