

A close-up of a financial statement table with columns for amounts and descriptions. The visible text includes:

100,000	
10,000	
10,000	
75,000	
\$205,000	



# Cost-Volume-Profit Relationships

## Chapter 5

# Learning Objectives

- Understand how changes in activity affect contribution margin and net operating income
- Understand cost-volume-profit (CVP) analysis for the break-even point and the target profit.
- Understand the effects of the changes in variable costs, fixed costs, selling price, and volume.
- Understand the margin of safety and the operation leverage resulted from cost structures.



# Basics of Cost-Volume-Profit Analysis

The contribution format 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.

Racing Bicycle Company Contribution Income Statement For the Month of June		
Sales (500 bicycles)	\$	250,000
Less: Variable expenses		150,000
Contribution margin		100,000
Less: Fixed expenses		80,000
Net operating income	\$	20,000

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		
	Total	Per Unit
Sales (500 bicycles)	\$ 250,000	\$ 500
Less: Variable expenses	150,000	300
Contribution margin	100,000	\$ 200
Less: Fixed expenses	80,000	
Net 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).

Racing Bicycle Company Contribution Income Statement For the Month of June		
	Total	Per Unit
Sales (500 bicycles)	\$ 250,000	\$ 500
Less: Variable expenses	150,000	300
Contribution margin	100,000	\$ 200
Less: Fixed expenses	80,000	
Net operating income	\$ 20,000	



# The Contribution Approach

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

Racing Bicycle Company Contribution Income Statement For the Month of June		
	Total	Per Unit
Sales ( <b>400</b> bicycles)	\$ 200,000	\$ 500
Less: Variable expenses	120,000	300
Contribution margin	80,000	\$ 200
Less: Fixed expenses	80,000	
Net operating income	\$ -	



# The Contribution Approach

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

Racing Bicycle Company Contribution Income Statement For the Month of June		
	Total	Per Unit
Sales ( <b>401</b> bicycles)	\$ 200,500	\$ 500
Less: Variable expenses	120,300	300
Contribution margin	80,200	\$ 200
Less: Fixed expenses	80,000	
Net operating income	<u>\$ 200</u>	



# 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.

$$\$200 \times 30 = \$6,000$$

If Racing sells 430 bikes, its net operating income will be \$6,000.

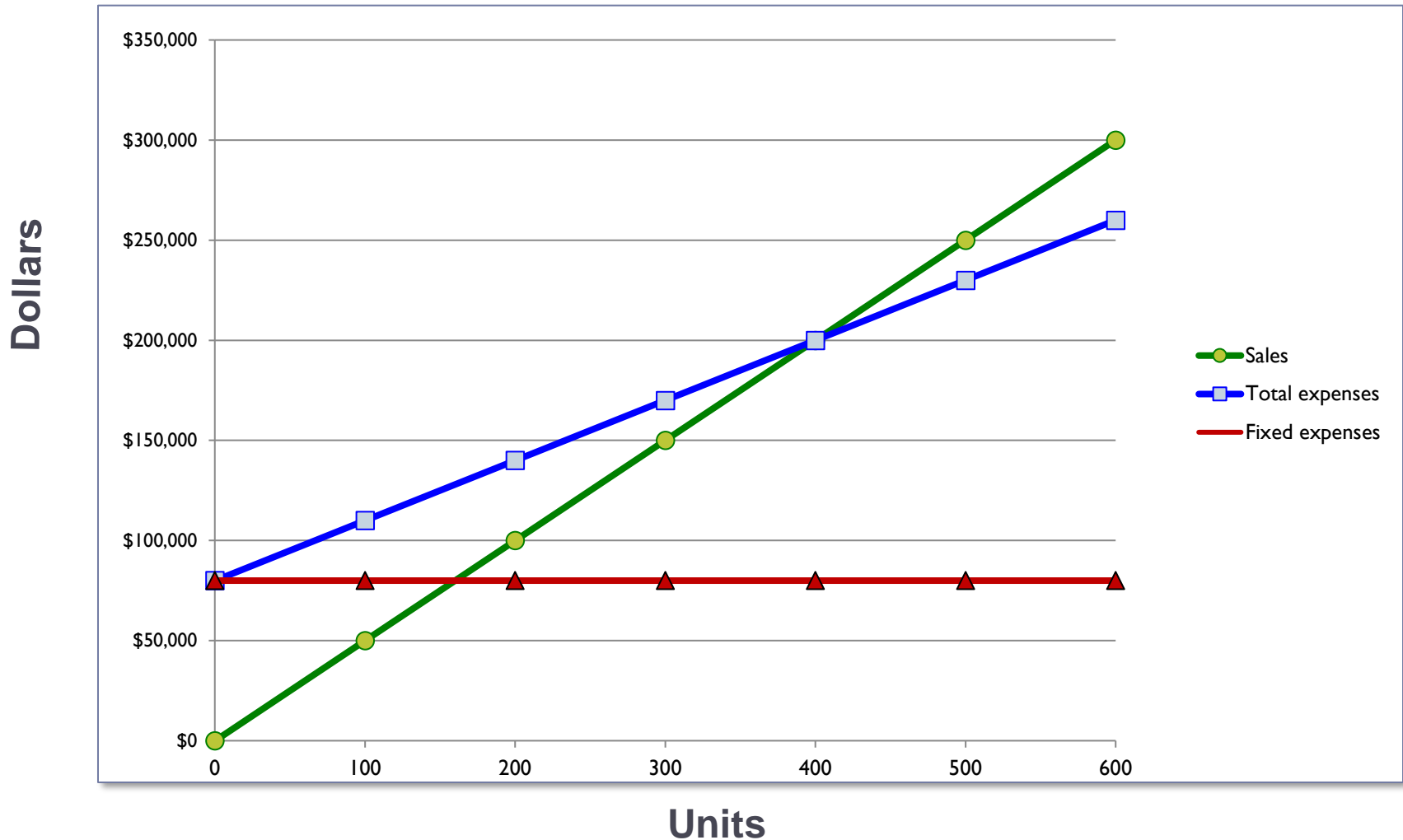




# Preparing the CVP Graph

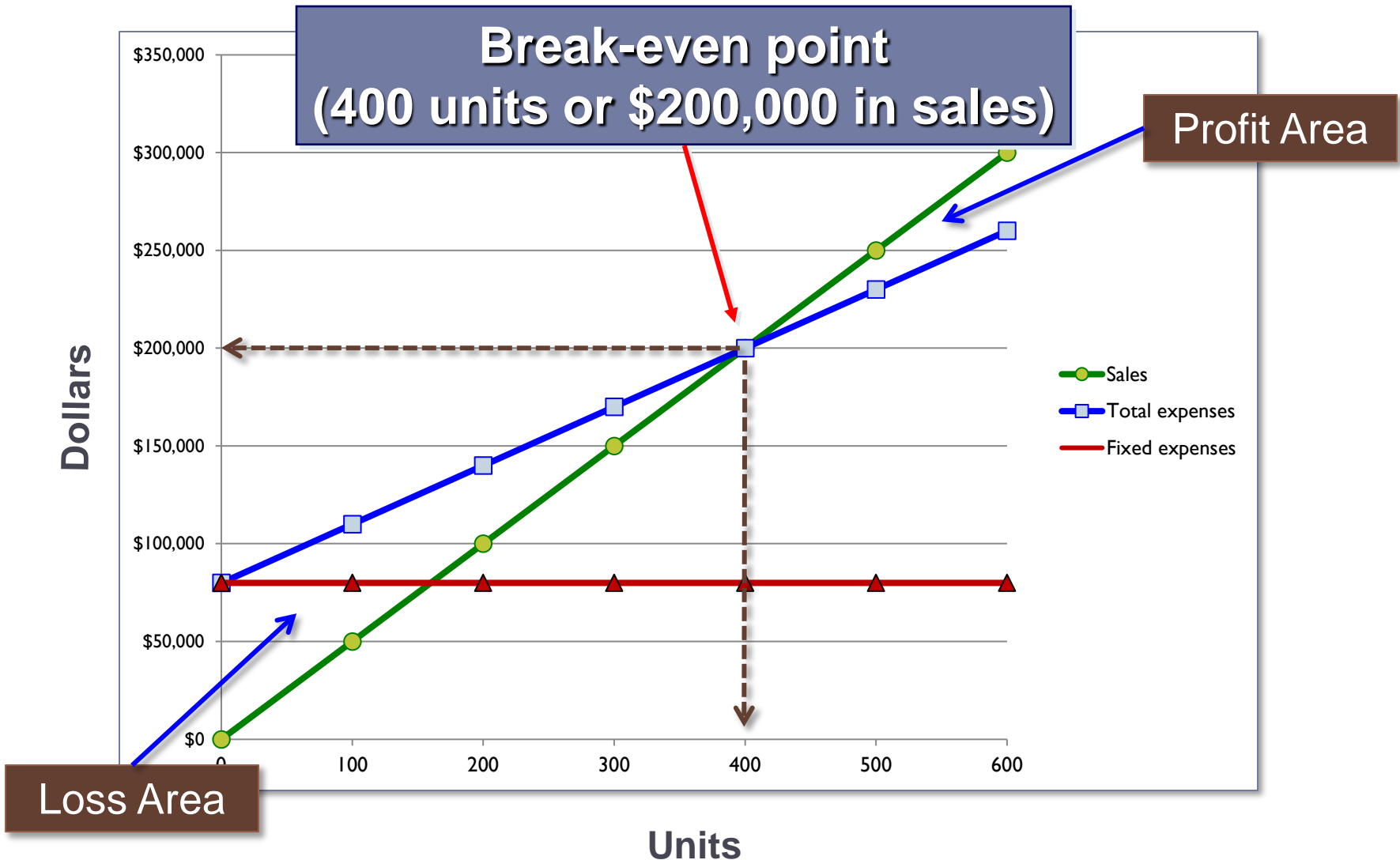


The green line represents the total sales revenue.  
The blue line represents the total expenses





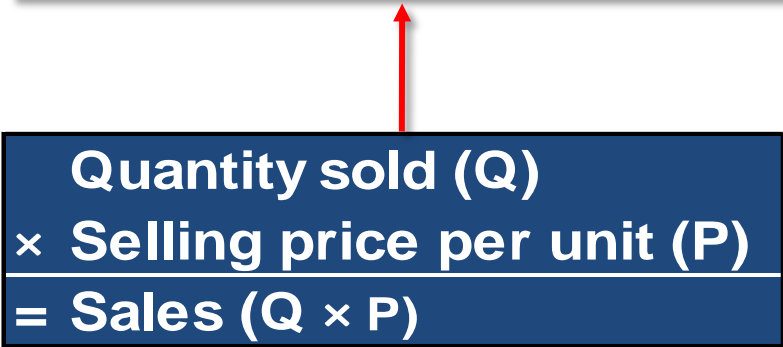
# Preparing the CVP Graph

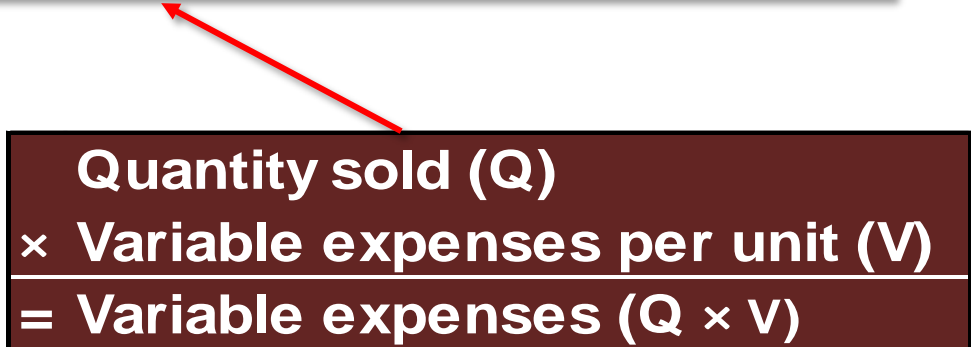


# CVP Relationships in Equation Form

When a company has only one product we can further refine this equation as shown on this slide.

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


$$\begin{array}{l} \text{Quantity sold (Q)} \\ \times \text{ Selling price per unit (P)} \\ \hline = \text{Sales (Q} \times \text{P)} \end{array}$$


$$\begin{array}{l} \text{Quantity sold (Q)} \\ \times \text{ Variable expenses per unit (V)} \\ \hline = \text{Variable expenses (Q} \times \text{V)} \end{array}$$

$$\begin{aligned} \text{Profit} &= (\text{P} \times \text{Q} - \text{V} \times \text{Q}) - \text{Fixed expenses} \\ &= (\text{P} - \text{V}) \times \text{Q} - \text{Fixed exp.} \\ &= \text{Unit Contribution margin} \times \text{Q} - \text{Fixed exp.} \end{aligned}$$



# Contribution Margin Ratio (CM Ratio)

The CM ratio is calculated by dividing the total contribution margin by total sales.

## Racing Bicycle Company Contribution Income Statement For the Month of June

	Total	Per Unit	CM Ratio
Sales (500 bicycles)	\$ 250,000	\$ 500	100%
Less: Variable expenses	150,000	300	60%
Contribution margin	100,000	\$ 200	40%
Less: Fixed expenses	80,000		
Net operating income	\$ 20,000		

$$\text{CM Ratio} = \frac{\text{CM per unit}}{\text{Price per unit}} = \frac{\$200}{\$500} = 40\%$$



# Contribution Margin Ratio (CM Ratio)

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

$$\text{Profit} = \text{CM ratio} \times \text{Sales} - \text{Fixed expenses}$$
$$\Delta \text{Profit} = \text{CM ratio} \times \Delta \text{Sales}$$

If Racing Bicycle increased its sales volume from 400 to 500 bikes, what is the change in the profit?

$$\Delta \text{Profit} = 40\% \times (\$500 \times 100)$$
$$\Delta \text{Profit} = \$20,000$$



## 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. A total of 2,100 cups are sold each month on average. What is the CM Ratio for Coffee Klatch?

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



How do we use the “2,100 cups” information?

## 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. A total of 2,100 cups are sold each month on average. What is the CM Ratio for Coffee Klatch?

a. 1.319

**b. 0.758**

c. 0.242

d. 4.139

$$\text{CM Ratio} = \frac{\text{Unit contribution margin}}{\text{Unit selling price}}$$

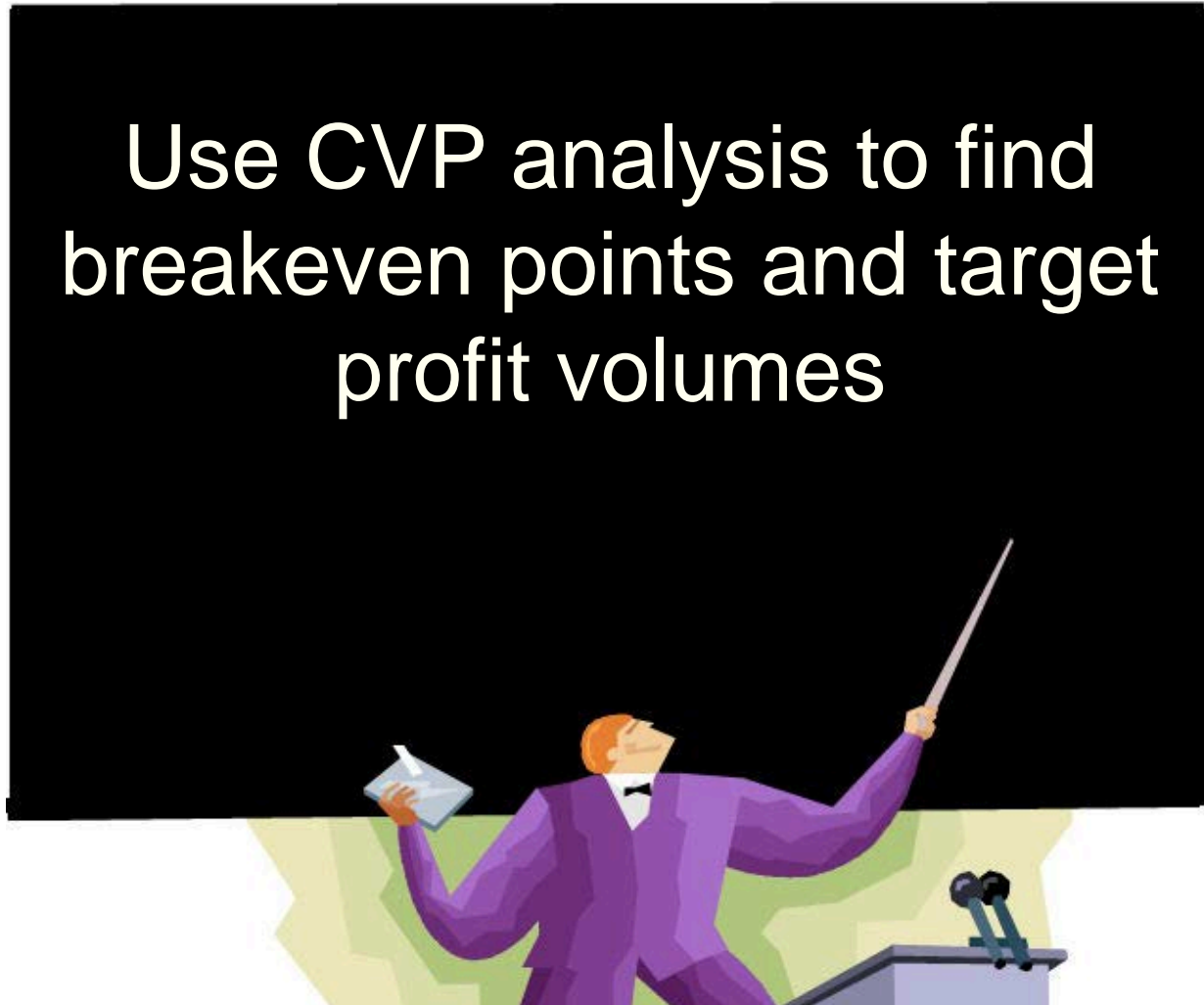
$$= \frac{(\$1.49 - \$0.36)}{\$1.49}$$

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

How does CM ratio vary with sales volume?

## Learning Objective 2

Use CVP analysis to find  
breakeven points and target  
profit volumes





# Five Components of CVP Analysis

- CVP analysis relies on the interdependency of five components or pieces of information
  - Sales price per unit
  - Volume sold
  - Variable costs per unit
  - Fixed costs
  - Operating income
- If you know or can estimate four of these five components, you can compute the remaining unknown amount

# CVP Assumptions

1. Linear cost function without the issue of cost stickiness.
2. Selling price is not affected by the volume changes.
3. Managers can classify each cost as either variable or fixed
4. Revenues are linear throughout relevant range
5. In manufacturing companies, inventory levels will not change
  - For manufacturing firms, it requires units produced = units sold; then the target is that total CM = total fixed cost for this period. Otherwise, not all fixed costs are recorded as expenses for this period.
  - For merchandisers, there is no such a constraint.
  - CVP is much more applicable for merchandisers or service company in the real business practices.
6. The sales mix of products will not change (Multi-product companies).



# Breakeven Point

Breakeven point:

- Sales level at which operating income is zero
- Total sales = total expenses
- Fixed expenses = total contribution margin

# Breakeven point: use CM per unit

Contribution Margin = Fixed Expense

Breakeven point (sold units) = Fixed Expenses/ CM per unit;

Example:

Kay has an e-tail poster business. She currently sells each poster for \$35, while each poster has a variable cost of \$21. Kay has fixed costs of \$7,000. Kay is currently selling 550 posters.

$$\text{CM per unit} = 35 - 21 = 14$$

$$\begin{aligned}\text{Units sold} &= \frac{\$7,000 + \$0}{\$14} \\ &= 500 \text{ posters}\end{aligned}$$

## 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. 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



Quick C

$$\text{Units sold for target profit} = \frac{\text{Target profit} + \text{Fixed exp.}}{\text{Unit CM}}$$

Coffee Kiosk building. The selling price is \$1.49 and the variable cost is \$0.36. The fixed costs are \$3,800. How many cups must be sold to attain target profit?

$$\begin{aligned} &= \frac{\$2,500 + \$1,300}{\$1.49 - \$0.36} \\ &= \frac{\$3,800}{\$1.13} \\ &= 3,363 \text{ cups} \end{aligned}$$

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



# Example

Hermann Corporation	Per Unit	Percent of Sales
Selling Price	\$90	100%
Variable Expenses	\$63	70%
Contribution Margin	\$27	
Fixed expenses are \$30,000 per month and the company is selling 2,000 units per month		

(1) The marketing manager argues that a \$5,000 increase in the monthly advertising budget would increase monthly sales by \$9,000. What is the change in net income?

(2) The use of higher-quality component would increase the variable expense by \$2 per unit. The marketing manager believes that the higher-quality product would increase sales by 10% per month. What is the change in net income?

# Answers to (1)

	<i>Current Sales</i>	<i>Sales With Additional Advertising Budget</i>	<i>Difference</i>
Sales .....	\$180,000	\$189,000	\$ 9,000
Variable expenses .....	<u>126,000</u>	<u>132,300</u>	<u>6,300</u>
Contribution margin.....	54,000	56,700	2,700
Fixed expenses .....	<u>30,000</u>	<u>35,000</u>	<u>5,000</u>
Net operating income .....	<u>\$ 24,000</u>	<u>\$ 21,700</u>	<u>\$ (2,300)</u>

OR: (a more efficient way)

Incremental contribution margin:

\$9,000 × 30% CM ratio .....	\$2,700
Less incremental advertising expense ....	<u>5,000</u>
Change in net operating income .....	<u>\$ (2,300)</u>



## Answers to (2)

The \$2 increase in variable expense will cause the unit contribution margin to decrease from \$27 to \$25

Expected total contribution margin with the higher-quality components:

2,200 units × \$25 per unit .....	\$55,000
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Present total contribution margin:

2,000 units × \$27 per unit .....	<u>54,000</u>
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Change in total contribution margin.....	<u><u>\$ 1,000</u></u>
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The decision depends on whether the total CM increases or not.

# In-class case: the proposal of Master's Degree Program

Background: a proposal by School of Business at HKU

- Motivation at the school level
- Motivation/concerns at the University level

## Case content

- Course curriculum/study load
- Proposed tuition fee & total revenues
- Teaching cost
- Admin. Expenses
- Other Indirect costs
- Expected profits and Break-even point

# In-class case: the proposal of Master's Degree Program

## Topics for discussions

- Calculation of Break-Even point at school-level
  - What is the equation?
  - Any role of fixed costs (FC)? Why?
  - How to improve the calculation?
  
- How about break-even point at University-level?
  - higher or lower than the one in the proposal?
  - Why?
  
- How do you think of the Margin of Safety for this proposal?
  - At the University level, how do they require a larger margin of safety?

## Learning Objective 3

Margin of safety and  
Operating leverage from  
the perspective of  
management accounting.





# 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.

Margin of safety in dollars = Total sales - 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.

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

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

# 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.

$$\text{DOL} = \text{Degree of Operating Leverage} = \frac{\text{Contribution Margin}}{\text{Net Operating Income}}^{**}$$

\*\* Profit Before Tax is a commonly used alternative to Net Operating Income in the degree of operating leverage calculation

Question: why? Can you do the mathematical proof?





# Operating Leverage

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

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

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





# 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		10%
Degree of operating leverage	×	<u>5</u>
Percent increase in profits		<u><u>50%</u></u>

**Here's the verification!**

# Operating Leverage

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

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

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

# In-Class Exercise: CVP Analysis

## Question 1:

Veren Inc. produces and sells two products. During the most recent month, Product F73A's sales were \$27,000 and its variable expenses were \$9,450. Product L75P's sales were \$14,000 and its variable expenses were \$5,310. The company's fixed expenses were \$21,060.

## Question 2:

Sebree Corporation has provided the following contribution format income statement:

Sales (7,000 units)	\$	280,000
Variable expenses		168,000
Contribution margin		112,000
Fixed expenses		105,600
Net operating income	\$	6,400

Given 5% in sales, what is change % in net income?

# Cost Structure and Profit Stability

$$\text{Operating Leverage} = \frac{CM}{\text{Profit}} = \frac{CM}{CM - \text{Fixed Cost}}$$

Therefore, **Higher Fixed Cost** suggests a higher **Operating leverage** and the profit change is **more sensitive** to the sales change.

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.

# Operating leverage in practice

- The volatility of sales and the operating leverage are the main drivers of changes in earnings.
- Companies with **rigid cost structures** are **more risky** compared to companies with flexible cost structures, because earnings react more sensitive to changes in sales.
- Because of the importance of earnings for analysts, investors but also executives, the operating leverage is the key information for the assessment of companies.

- ▶ For high operating leverage companies, changes in sales volume significantly affect operating income, so they face:
  - ▶ *Higher risk*
  - ▶ *Higher potential for reward*
- ▶ Examples include golf courses, hotels, rental car agencies, theme parks, airlines, cruise lines

# Operating leverage in practice

- **Desirable cost structure** in the period of sales expanding
  - ✓ the analyst report for Luk Fook Holdings (590.hk)(六福珠宝)
  - ✓ **In 2011**, High operating leverage is treated as a good cost structure.
  - ✓ See the report.

- **Undesirable cost structure** in the period of weak economy
  - ✓ the analyst report for Luk Fook Holdings (590.hk)(六福珠宝)
  - ✓ **In 2016**, operating “deleverage” is expected.
  - ✓ Store consolidation for lower rental burden.
  - ✓ See the report.

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

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

## Quick Check ✓

Coffee Klatch is an espresso stand in a downtown office building. The average price of a cup of coffee is \$1.50, and the variable expense per cup is \$0.60. The fixed expense per month for rent is \$1,300. If 2,100 cups are sold each month, what is the operating leverage?

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

a. 2.21

b. 0.45

c. 0.34

d. 2.92

$$\begin{aligned}\text{Operating leverage} &= \frac{\text{Contribution margin}}{\text{Net operating income}} \\ &= \frac{\$2,373}{\$1,073} = 2.21\end{aligned}$$



## 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%



## 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%**

<b>Percent increase in sales</b>	<b>20.0%</b>
<b>× Degree of operating leverage</b>	<b>2.21</b>
<b>Percent increase in profit</b>	<b>44.20%</b>

To Verify the answer

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

# 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:



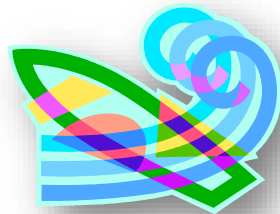
Pipeline Unlimited produces two types of surfboards, the XR7 and the Turbo. The XR7 sells for \$100 and generates a contribution margin per unit of \$25. The Turbo sells for \$150 and earns a contribution margin per unit of \$18.

# Structuring Sales Commissions

The sales force at Pipeline Unlimited is compensated based on sales commissions. *Which product will you sell harder?*

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.



In-class case analysis:

## Carlsbad Home Care

- Download the case article from the Moodle.

**Homework #1:** See the file on the Moodle.

- Deadline: to be announced



## End of Chapter 5