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Cost-Volume-Profit

Chapter Preview

As the following Feature Story indicates, to manage any size business you must understand how costs respond to changes in sales volume and the effect of costs and revenues on profits. A prerequisite to understanding cost-volume-profit (CVP) relationships is knowledge of how costs behave. In this chapter, we first explain the considerations involved in cost behavior analysis. Then, we discuss and illustrate CVP analysis.

Feature Story

Don't Worry—Just Get Big

It wasn't that Jeff didn't have a good job. He was a vice president at a Wall Street firm. But, despite his good position, he quit his job, moved to Seattle, and started an online retailer, which he named **Amazon.com**. Like any good entrepreneur, Jeff Bezos strove to keep his initial investment small. Operations were run out of his garage. And, to avoid the need for a warehouse, he took orders for books and had them shipped from other distributors' warehouses.

By its fourth month, Amazon was selling 100 books a day. In its first full year, it had \$15.7 million in sales. The next year, sales increased eightfold. Two years later, sales were \$1.6 billion.


Although its sales growth was impressive, Amazon's ability to lose money was equally amazing. One analyst nicknamed it *Amazon.bomb*, while another, predicting its demise, called it *Amazon.toast*. Why was it losing money? The company used every available dollar to reinvest in itself. It built massive warehouses and bought increasingly sophisticated (and expensive) computers and equipment to improve its distribution system. This desire to grow as fast as possible was captured in a T-shirt

slogan at its company picnic, which read “Eat another hot dog, get big fast.” This buying binge was increasing the company’s fixed costs at a rate that exceeded its sales growth. Skeptics predicted that Amazon would soon run out of cash. It didn’t.

At the end of one year, even as it announced record profits, Amazon’s share price fell by 9%. Why? Because although the company was predicting that its sales revenue in the next quarter would increase by at least 28%, it predicted that its operating profit would fall by at least 2% and perhaps by as much as 34%. The company made no apologies. It explained that it was in the process of expanding from 39 distribution

centers to 52. As Amazon’s finance chief noted, “You’re not as productive on those assets for some time. I’m very pleased with the investments we’re making and we’ve shown over our history that we’ve been able to make great returns on the capital we invest in.” In other words, eat another hot dog.

Sources: Christine Frey and John Cook, “How Amazon.com Survived, Thrived and Turned a Profit,” *Seattle Post* (January 28, 2008); Stu Woo, “Sticker Shock Over Amazon Growth,” *Wall Street Journal* (January 28, 2011); and Miriam Gutfried, “Amazon’s Never-Ending Story,” *Wall Street Journal* (April 25, 2014).

 **Video**

Watch the *Southwest Airlines* video in WileyPLUS to learn more about cost-volume-profit analysis in the real world.

Chapter Outline

LEARNING OBJECTIVES

LO 1 Explain variable, fixed, and mixed costs and the relevant range.	<ul style="list-style-type: none">• Variable costs• Fixed costs• Relevant range• Mixed costs	DO IT! 1 Types of Costs
LO 2 Apply the high-low method to determine the components of mixed costs.	<ul style="list-style-type: none">• High-low method• Identifying variable and fixed costs	DO IT! 2 High-Low Method
LO 3 Prepare a CVP income statement to determine contribution margin.	<ul style="list-style-type: none">• Basic components• CVP income statement	DO IT! 3 CVP Income Statement
LO 4 Compute the break-even point using three approaches.	<ul style="list-style-type: none">• Mathematical equation• Contribution margin technique• Graphic presentation	DO IT! 4 Break-Even Analysis
LO 5 Determine the sales required to earn target net income and determine margin of safety.	<ul style="list-style-type: none">• Target net income• Margin of safety	DO IT! 5 Break-Even, Margin of Safety, and Target Net Income
Go to the Review and Practice section at the end of the chapter for a review of key concepts and practice applications with solutions. Visit WileyPLUS with Orion for additional tutorials and practice opportunities.		

Cost Behavior Analysis

LEARNING OBJECTIVE 1

Explain variable, fixed, and mixed costs and the relevant range.

Cost behavior analysis is the study of how specific costs respond to changes in the level of business activity. As you might expect, some costs change when activity changes and others remain the same. For example, for an airline company such as **Southwest** or **United**, the longer

the flight, the higher the fuel costs. On the other hand, **Massachusetts General Hospital's** costs to staff the emergency room on any given night are relatively constant regardless of the number of patients treated. 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.

The starting point in cost behavior analysis is measuring the 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), or dance classes taught (by a dance studio). Many companies use more than one measurement base. A manufacturer, for example, may use direct labor hours or units of output for manufacturing costs, and sales revenue or units sold for selling expenses.

For an activity level to be useful in cost behavior analysis, changes in the level or volume of activity should be correlated with changes in costs. The activity level selected is referred to as the activity index or driver. The **activity index** identifies the activity that causes changes in the behavior of costs. With an appropriate activity index, companies can classify the behavior of costs in response to changes in activity levels into three categories: variable, fixed, or mixed.

Variable Costs

Variable costs are costs that vary **in total** directly and proportionately with changes in the activity level. If the level increases 10%, total variable costs will increase 10%. If the level of activity decreases by 25%, variable costs will decrease 25%. Examples of variable costs include direct materials and direct labor for a manufacturer; cost of goods sold, sales commissions, and freight-out for a merchandiser; and gasoline in airline and trucking companies. A variable cost may also be defined as a cost that **remains the same per unit at every level of activity**.

To illustrate the behavior of a variable cost, assume that Damon Company manufactures tablet computers that contain cameras that cost \$10. The activity index is the number of tablet computers produced. As Damon manufactures each tablet, the total cost of cameras installed in tablets increases by \$10. As part (a) of **Illustration 22.1** shows, total cost of the cameras will be \$20,000 ($2,000 \times \10) if Damon produces 2,000 tablets, and \$100,000 when it produces 10,000 tablets. We also can see that a variable cost remains the same per unit as the level of activity changes. As part (b) of **Illustration 22.1** shows, the unit cost of \$10 for the cameras is the same whether Damon produces 2,000 or 10,000 tablets.

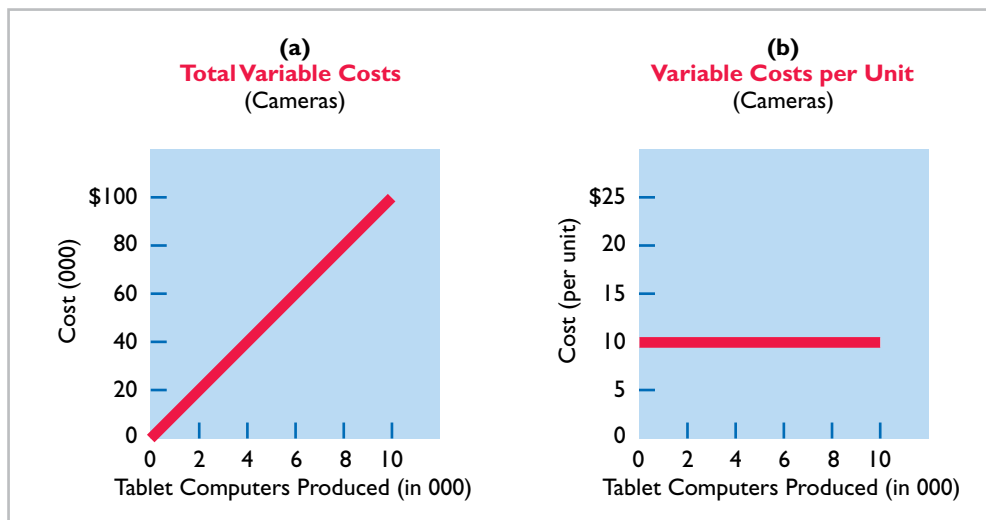


ILLUSTRATION 22.1

Behavior of total and unit variable costs; variable costs per unit remain constant

Companies that rely heavily on labor either to manufacture a product or perform a service, such as **Hilton** or **Marriott**, are likely to have a high percentage of variable costs. In contrast, companies that use a high proportion of machinery and equipment in producing revenue, such as **AT&T** or **Duke Energy Co.**, may have a lower percentage of variable costs.

Fixed Costs

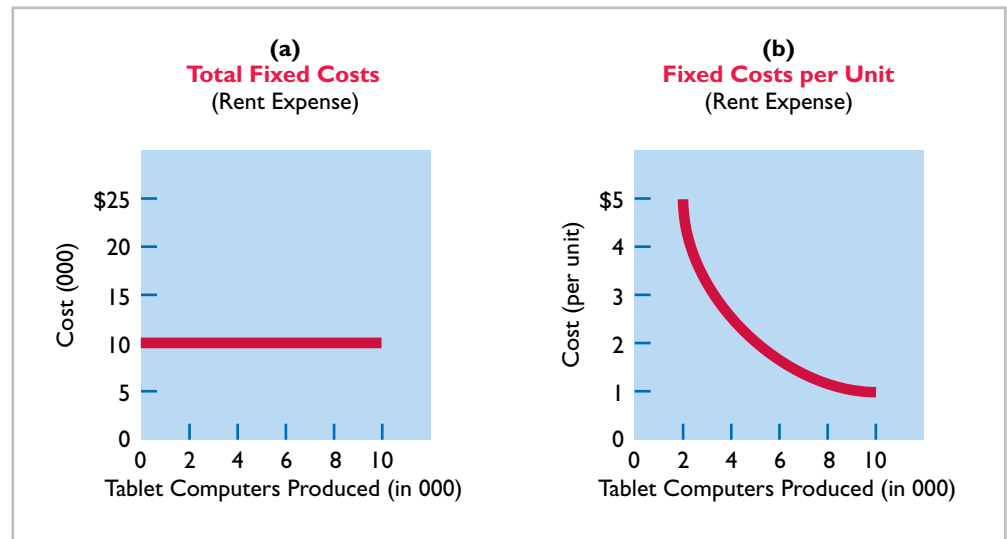
Fixed costs are costs that **remain the same in total** regardless of changes in the activity level. Examples include property taxes, insurance, rent, supervisory salaries, and depreciation

on buildings and equipment. Because total fixed costs remain constant as activity changes, it follows that **fixed costs per unit vary inversely with activity: As volume increases, unit cost declines, and vice versa.**

To illustrate the behavior of fixed costs, assume that Damon Company leases its productive facilities at a cost of \$10,000 per month. Total fixed costs of the facilities remain a constant \$10,000 at every level of activity, as part (a) of **Illustration 22.2** shows. But, **on a per unit basis, the cost of rent declines as activity increases**, as part (b) of Illustration 22.2 shows. At 2,000 units, the unit cost per tablet computer is \$5 ($\$10,000 \div 2,000$). When Damon produces 10,000 tablets, the unit cost of the rent is only \$1 per tablet ($\$10,000 \div 10,000$).

ILLUSTRATION 22.2

Behavior of total and unit fixed costs



The trend for many manufacturers is to have more fixed costs and fewer variable costs. This trend is the result of increased use of automation and less use of employee labor. As a result, depreciation and lease charges (fixed costs) increase, whereas direct labor costs (variable costs) decrease.

People, Planet, and Profit Insight BrightFarms



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Gardens in the Sky

Because of population increases, the United Nations' Food and Agriculture Organization estimates that food production will need to increase by 70% by 2050. Also, by 2050, roughly 70% of people will live in cities, which means more food needs to be hauled further to get it to the consumer. To address the lack of farmable land and reduce the cost of transporting produce, some companies, such as New York-based **BrightFarms**, are building urban greenhouses.

This sounds great, but do the numbers work? Some variable costs would be reduced. For example, the use of pesticides, herbicides, fuel costs for shipping, and water would all drop. Soil erosion would

be a non-issue since plants would be grown hydroponically (in a solution of water and minerals), and land requirements would be reduced because of vertical structures. But, other costs would be higher. First, there is the cost of the building. Also, any multistory building would require artificial lighting for plants on lower floors.

Until these cost challenges can be overcome, it appears that these urban greenhouses may not break even. On the other hand, rooftop greenhouses on existing city structures already appear financially viable. For example, a 15,000 square-foot rooftop greenhouse in Brooklyn already produces roughly 30 tons of vegetables per year for local residents.

Sources: "Vertical Farming: Does It Really Stack Up?" *The Economist* (December 9, 2010); and Jane Black, "BrightFarms Idea: Greenhouses That Cut Short the Path from Plant to Grocery Shelf," *The Washington Post* (May 7, 2013).

What are some of the variable and fixed costs that are impacted by hydroponic farming? (Go to WileyPLUS for this answer and additional questions.)

Relevant Range

In Illustration 22.1 part (a), a straight line is drawn throughout the entire range of the activity index for total variable costs. In essence, the assumption is that the costs are **linear**. If a relationship is linear (that is, straight-line), then changes in the activity index will result in a direct, proportional change in the total variable cost. For example, if the activity level doubles, the cost doubles.

It is now necessary to ask: Is the straight-line relationship realistic? In most business situations, a straight-line relationship **does not exist** for variable costs throughout the entire range of possible activity. At abnormally low levels of activity, it may be impossible to be cost-efficient. Small-scale operations may not allow the company to obtain quantity discounts for raw materials or to use specialized labor. In contrast, at abnormally high levels of activity, labor costs may increase sharply because of overtime pay. Also, at high activity levels, materials costs may jump significantly because of excess spoilage caused by worker fatigue.

As a result, in the real world, the relationship between the behavior of a variable cost and changes in the activity level is often **curvilinear**, as shown in part (a) of **Illustration 22.3**. In the curved sections of the line, a change in the activity index will not result in a direct, proportional change in the variable cost. That is, a doubling of the activity index will not result in an exact doubling of the variable cost. The variable cost may more than double, or it may be less than double.

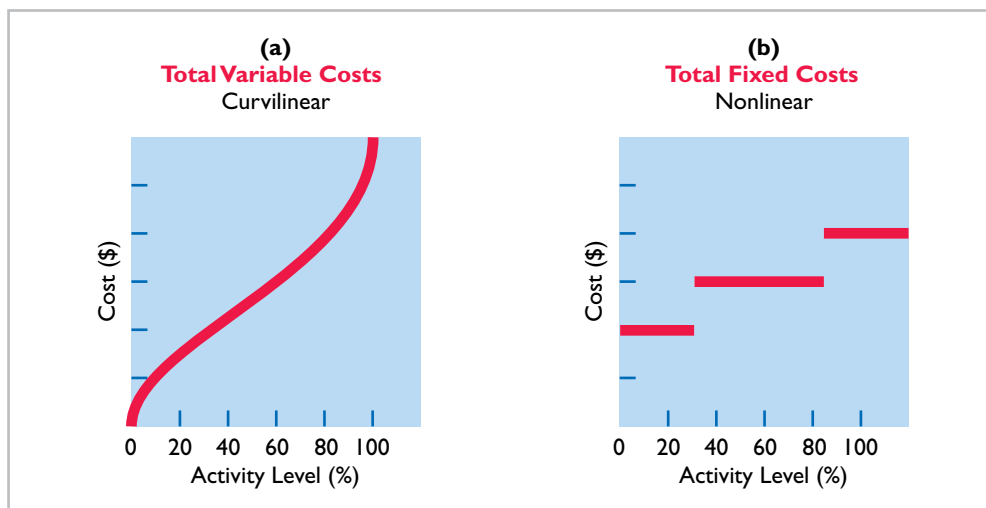


ILLUSTRATION 22.3

Nonlinear behavior of variable and fixed costs

Total fixed costs also do not have a straight-line relationship over the entire range of activity. Some fixed costs will not change. But it is possible for management to change other fixed costs (see **Helpful Hint**). For example, in some instances, salaried employees (fixed) are replaced with freelance workers (variable). Some costs are step costs. For example, once a company exceeds certain levels of activity, it may have to add an additional warehouse. Illustration 22.3, part (b), shows an example of step-cost behavior of total fixed costs through all potential levels of activity.

For most companies, operating at almost zero or at 100% capacity is the exception rather than the rule. Instead, companies often operate over a somewhat narrower range, such as 40–80% of capacity. The range over which a company expects to operate during a year is called the **relevant range** of the activity index (see **Alternative Terminology**). Within the relevant range, as both diagrams in **Illustration 22.4** show, a straight-line relationship generally exists for both variable and fixed costs between 40 and 80% of capacity.

HELPFUL HINT

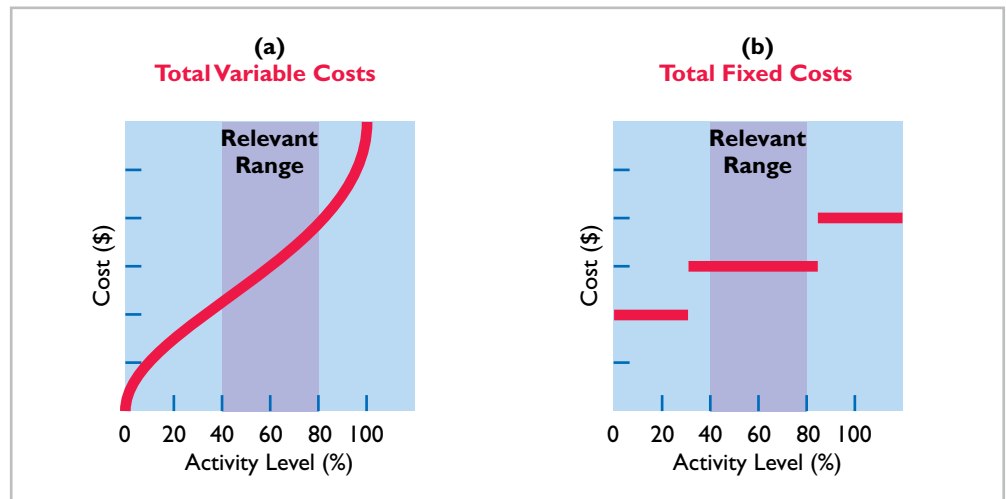
Fixed costs that may be changed by managers include research, such as new product development, and management training programs.

ALTERNATIVE TERMINOLOGY

The relevant range is also called the *normal* or *practical range*.

ILLUSTRATION 22.4

Linear behavior within relevant range



As you can see, although the linear (straight-line) relationship may not be completely realistic, **the linear assumption produces useful data for CVP analysis as long as the level of activity remains within the relevant range.**

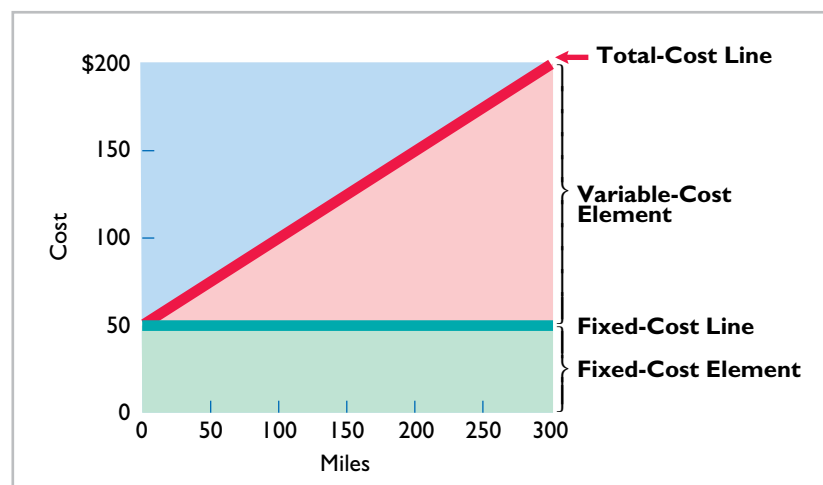
Mixed Costs

Mixed costs are costs that contain both a variable- and a fixed-cost element. **Mixed costs, therefore, change in total but not proportionately with changes in the activity level.**

The rental of a **U-Haul** truck is a good example of a mixed cost. Assume that local rental terms for a 17-foot truck, including insurance, are \$50 per day plus 50 cents per mile. When determining the cost of a one-day rental, the per day charge is a fixed cost (with respect to miles driven), whereas the mileage charge is a variable cost. The graphic presentation of the rental cost for a one-day rental is shown in **Illustration 22.5**.

ILLUSTRATION 22.5

Behavior of a mixed cost



In this case, the fixed-cost element is the cost of having the service available. The variable-cost element is the cost of actually using the service (miles driven). Utility costs such as electricity are another example of a mixed cost. Each month the electric bill includes a flat service fee plus a usage charge.

DO IT! 1 | Types of Costs

Helena Company reports the following total costs at two levels of production.

	<u>10,000 Units</u>	<u>20,000 Units</u>
Direct materials	\$20,000	\$40,000
Maintenance	8,000	10,000
Direct labor	17,000	34,000
Indirect materials	1,000	2,000
Depreciation	4,000	4,000
Utilities	3,000	5,000
Rent	6,000	6,000

Classify each cost as variable, fixed, or mixed.

ACTION PLAN

- Recall that a variable cost varies in total directly and proportionately with each change in activity level.
- Recall that a fixed cost remains the same in total with each change in activity level.
- Recall that a mixed cost changes in total but not proportionately with each change in activity level.

Solution

Direct materials, direct labor, and indirect materials are variable costs because the total cost doubles with the doubling in activity.

Depreciation and rent are fixed costs because the total cost does not vary with the change in activity. Maintenance and utilities are mixed costs because the total cost changes, but the change is not proportional to the change in activity.

Related exercise material: BE22.1, BE22.2, BE22.3, DO IT! 22.1, E22.1, E22.2, E22.4, and E22.6.

Mixed Costs Analysis

LEARNING OBJECTIVE 2

Apply the high-low method to determine the components of mixed costs.

For purposes of cost-volume-profit analysis, **mixed costs must be classified into their fixed and variable elements**. How does management make the classification? One possibility is to determine the variable and fixed components each time a mixed cost is incurred. But because of time and cost constraints, this approach is rarely followed. Instead, the usual approach is to collect data on the behavior of the mixed costs at various levels of activity. Analysts then identify the fixed- and variable-cost components. Companies use various types of analysis. One type of analysis, called the **high-low method**, is discussed next.

High-Low Method

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 the variable-cost element can change as activity levels change.

The steps in computing fixed and variable costs under this method are as follows.

1. Determine variable cost per unit from the formula shown in **Illustration 22.6**. This is the slope of the cost function.

$$\frac{\text{Change in Total Costs at High versus Low Activity Level}}{\text{High minus Low Activity Level}} = \text{Variable Cost per Unit}$$

ILLUSTRATION 22.6

Formula for variable cost per unit using high-low method

To illustrate, assume that Metro Transit Company has the maintenance costs and mileage data for its fleet of buses over a 6-month period shown in **Illustration 22.7**.

ILLUSTRATION 22.7

Assumed maintenance costs and mileage data

Month	Miles Driven	Total Cost	Month	Miles Driven	Total Cost
January	20,000	\$30,000	April	50,000	\$63,000
February	40,000	48,000	May	30,000	42,000
March	35,000	49,000	June	43,000	61,000

The high and low levels of activity are 50,000 miles in April and 20,000 miles in January. The maintenance costs at these two levels are \$63,000 and \$30,000, respectively. The difference in maintenance costs is \$33,000 (\$63,000 – \$30,000), and the difference in miles is 30,000 (50,000 – 20,000). Therefore, for Metro Transit, variable cost per unit is \$1.10, computed as follows.

$$\$33,000 \div 30,000 = \$1.10$$

2. Determine the total fixed costs by subtracting the total variable costs at either the high or the low activity level from the total cost at that activity level.

Illustration 22.8 shows the computations for Metro Transit.

ILLUSTRATION 22.8

High-low method computation of fixed costs

Metro Transit				
Home Insert Page Layout Formulas Data Review View				
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	A	B	C	D
1	Metro Transit			
2			Activity Level	
3			High	Low
4	Total cost		\$63,000	\$30,000
5	Less:	Variable costs		
6		50,000 × \$1.10	55,000	
7		20,000 × \$1.10		22,000
8	Total fixed costs		\$ 8,000	\$ 8,000
9				
10				

Maintenance costs are therefore \$8,000 per month of fixed costs plus \$1.10 per mile of variable costs. This is represented by the following formula, referred to as the total cost equation.

$$\text{Maintenance costs} = \$8,000 + (\$1.10 \times \text{Miles driven})$$

For example, at 45,000 miles, estimated maintenance costs would be \$8,000 fixed and \$49,500 variable (\$1.10 × 45,000) for a total of \$57,500.

The graph in **Illustration 22.9** plots the 6-month data for Metro Transit Company. The red line drawn in the graph connects the high and low data points (in squares) and therefore represents the equation that we just solved using the high-low method. The red, “high-low” line intersects the y-axis at \$8,000 (the fixed-cost level), and it rises by its slope of \$1.10 per unit (the variable cost per unit). Note that a completely different line would result if we chose any two of the other data points. That is, by choosing any two other data points, we would end up with a different estimate of fixed costs and a different variable cost per unit. Thus, from this scatter plot, we can see that while the high-low method is simple, the result is rather arbitrary. A better approach, which uses information from all the data points to estimate fixed and variable costs, is called *regression analysis*. A discussion of regression analysis is provided in Appendix 22A as well as in the Excel video available in WileyPLUS.

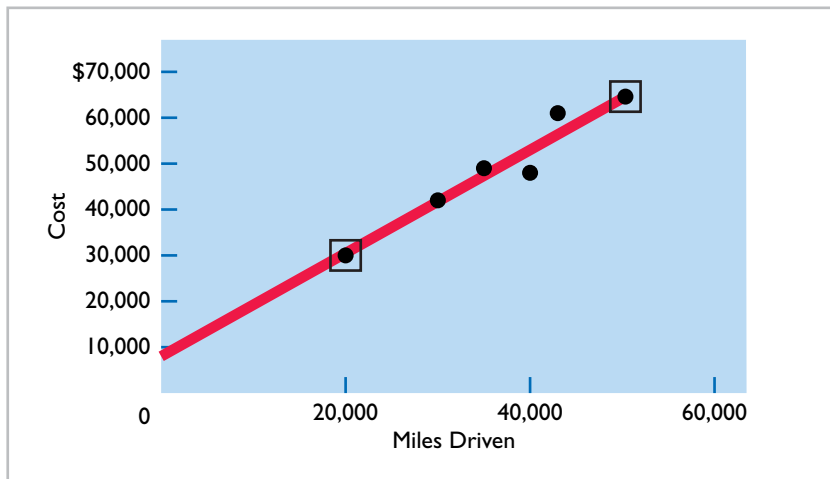


ILLUSTRATION 22.9

Scatter plot for Metro Transit Company

Management Insight Kroger Co.



tiero/iStock/Getty Images

Are Robotic Workers More Humane?

Warehouse distribution centers for large retailers and grocers employ more than 800,000 people in the United States. But many companies, such as grocer

Kroger Co., have a hard time finding and retaining warehouse workers. One reason? Studies have shown that some warehouse workers walk up to 20 miles and lift 50,000 pounds during a single day. As a result, as the needs for storage increases and companies are faced with the proposition of building massive new warehouses, some are choosing instead to invest in robotic warehousing systems.

Robots can provide many advantages over their human counterparts. Robots need aisles that are less than 30 inches wide, as opposed to traditional warehouse aisles that are 10 to 12 feet wide. Moving at speeds of up to 25 miles per hour, robots can drop off and retrieve warehouse cases about five times as fast as a human. Robotic systems cut labor costs by about 80%, and they cut warehouse size anywhere from 25% to 40%. However, a fully automated system costs between \$40 to \$80 million, so the switch to robotic systems is not a trivial decision.

Source: Robbie Whelan, "Fully Autonomous Robots: The Warehouse Workers of the Near Future," *Wall Street Journal* (September 20, 2016).

How would a company's variable and fixed costs change if it adopts a robotic system? (Go to WileyPLUS for this answer and additional questions).

Importance of Identifying Variable and Fixed Costs

Why is it important to segregate mixed costs into variable and fixed elements? The answer may become apparent if we look at the following four business decisions.

1. If **American Airlines** is to make a profit when it reduces all domestic fares by 30%, what reduction in costs or increase in passengers will be required?
Answer: To make a profit when it cuts domestic fares by 30%, American Airlines will have to increase the number of passengers or cut its variable costs for those flights. Its fixed costs will not change.
2. If **Ford Motor Company** meets workers' demands for higher wages, what increase in sales revenue will be needed to maintain current profit levels?
Answer: Higher wages at Ford Motor Company will increase the variable costs of manufacturing automobiles. To maintain present profit levels, Ford will have to cut other variable or fixed costs, sell more automobiles, or increase the price of its automobiles.
3. If **United States Steel Corp.**'s program to modernize plant facilities through significant equipment purchases reduces the work force by 50%, what will be the effect on the cost of producing one ton of steel?

Answer: The modernizing of plant facilities at United States Steel Corp. changes the proportion of fixed and variable costs of producing one ton of steel. Fixed costs increase because of higher depreciation charges, whereas variable costs decrease due to the reduction in the number of steelworkers.

4. What happens if **Kellogg's** increases its advertising expenses but cannot increase prices because of competitive pressure?

Answer: Sales volume must be increased to cover the increase in fixed advertising costs.

DO IT! 2 | High-Low Method

Byrnes Company accumulates the following data concerning a mixed cost, using units produced as the activity level.

	<u>Units Produced</u>	<u>Total Cost</u>
March	9,800	\$14,740
April	8,500	13,250
May	7,000	11,100
June	7,600	12,000
July	8,100	12,460

- Compute the variable-cost and fixed-cost elements using the high-low method.
- Using the information from your answer to part (a), write the cost formula.
- Estimate the total cost if the company produces 8,000 units.

Solution

- Variable cost: $(\$14,740 - \$11,100) \div (9,800 - 7,000) = \1.30 per unit
 Fixed cost: $\$14,740 - (\$1.30 \times 9,800 \text{ units}) = \$2,000$
 or $\$11,100 - (\$1.30 \times 7,000 \text{ units}) = \$2,000$
- Cost = $\$2,000 + (\$1.30 \times \text{units produced})$
- Total cost to produce 8,000 units: $\$2,000 + \$10,400 (\$1.30 \times 8,000 \text{ units}) = \$12,400$

Related exercise material: **BE22.4, BE22.5, DO IT! 22.2, E22.3, and E22.5.**

ACTION PLAN

- Determine the highest and lowest levels of activity.
- Compute variable cost per unit as $\text{Change in total costs} \div (\text{High} - \text{low activity level}) = \text{Variable cost per unit}$.
- Compute fixed cost as $\text{Total cost} - (\text{Variable cost per unit} \times \text{Units produced}) = \text{Total fixed cost}$.

Cost-Volume-Profit Analysis

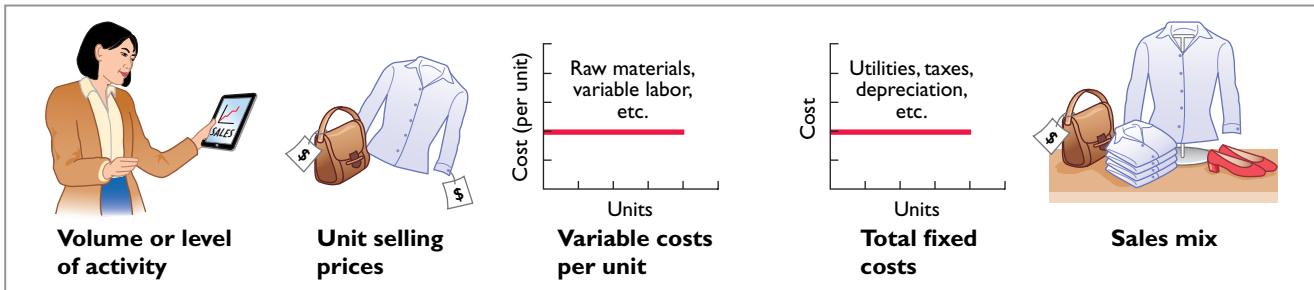
LEARNING OBJECTIVE 3

Prepare a CVP income statement to determine contribution margin.

Cost-volume-profit (CVP) analysis is the study of the effects of changes in costs and volume on a company's profits. CVP analysis is important in profit planning. It also is a critical factor in such management decisions as setting selling prices, determining product mix, and maximizing use of production facilities.

Basic Components

CVP analysis considers the interrelationships among the components shown in **Illustration 22.10**.

ILLUSTRATION 22.10 Components of CVP analysis

The following assumptions underlie each CVP analysis.

1. The behavior of both costs and revenues is linear throughout the relevant range of the activity index.
2. Costs can be classified accurately as either variable or fixed.
3. Changes in activity are the only factors that affect costs.
4. All units produced are sold.
5. When more than one type of product is sold, the sales mix will remain constant. That is, the percentage that each product represents of total sales will stay the same. Sales mix complicates CVP analysis because different products will have different cost relationships. In this chapter, we assume a single product.

When these assumptions are not valid, the CVP analysis may be inaccurate.

CVP Income Statement

Because CVP is so important for decision-making, management often wants this information reported in a **cost-volume-profit (CVP) income statement** format for internal use. The CVP income statement classifies costs as variable or fixed and computes a contribution margin. **Contribution margin (CM)** is the amount of revenue remaining after deducting variable costs. It is often stated both as a total amount and on a per unit basis.

We use Vargo Electronics Company to illustrate a CVP income statement. Vargo Electronics produces cell phones. **Illustration 22.11** presents relevant data for the cell phones sold by this company in June 2020.

Unit selling price of cell phone	\$500
Unit variable costs*	\$300
Total monthly fixed costs**	\$200,000
Units sold	1,600

*Includes variable manufacturing costs and variable selling and administrative expenses.

**Includes fixed manufacturing costs and fixed selling and administrative expenses.

ILLUSTRATION 22.11

Assumed selling and cost data for Vargo Electronics

Note that in Illustration 22.11, as well as in the applications and assignment material of CVP analysis that follow, **we assume that the term “cost” includes all costs and expenses related to production and sale of the product. That is, cost includes manufacturing costs plus selling and administrative expenses.**

The CVP income statement for Vargo would therefore be reported as shown in **Illustration 22.12**.

A traditional income statement and a CVP income statement both report the same net income of \$120,000. However, a traditional income statement does not classify costs as variable or fixed, and therefore it does not report a contribution margin. In addition, sometimes per unit amounts and percentage of sales amounts are shown in separate columns on a CVP income statement to facilitate CVP analysis. *Homework assignments specify which columns to present.*

ILLUSTRATION 22.12

CVP income statement, with net income

Vargo Electronics Company CVP Income Statement For the Month Ended June 30, 2020	
	Total
Sales (1,600 × \$500)	\$800,000
Variable costs (1,600 × \$300)	480,000
Contribution margin	320,000
Fixed costs	200,000
Net income	\$120,000

Unit Contribution Margin

Illustration 22.13 shows the formula for **unit contribution margin** and the computation for Vargo Electronics.

ILLUSTRATION 22.13

Formula for unit contribution margin

Unit Selling Price	—	Unit Variable Costs	=	Unit Contribution Margin
\$500	—	\$300	=	\$200

Unit contribution margin indicates that for every cell phone sold, the selling price exceeds the variable costs by \$200. Vargo generates \$200 per unit sold to cover fixed costs and contribute to net income. Because Vargo has fixed costs of \$200,000, it must sell 1,000 cell phones ($\$200,000 \div \200) to cover its fixed costs.

At the point where total contribution margin exactly equals fixed costs, Vargo will report net income of zero. At this point, referred to as the **break-even point**, total costs (variable plus fixed) exactly equal total revenue. **Illustration 22.14** shows Vargo's CVP income statement at the point where net income equals zero. It shows a contribution margin of \$200,000, and a unit contribution margin of \$200 ($\$500 - \300).

ILLUSTRATION 22.14

CVP income statement, with zero net income

Vargo Electronics Company CVP Income Statement For the Month Ended June 30, 2020		
	Total	Per Unit
Sales (1,000 × \$500)	\$500,000	\$500
Variable costs (1,000 × \$300)	300,000	300
Contribution margin	200,000	\$200
Fixed costs	200,000	
Net income	\$ -0-	

It follows that for every cell phone sold above the break-even point of 1,000 units, **net income increases by the amount of the unit contribution margin, \$200**. For example, assume that Vargo sold one more cell phone, for a total of 1,001 cell phones sold. In this case, Vargo reports net income of \$200, as shown in **Illustration 22.15**.

ILLUSTRATION 22.15

CVP income statement, with net income and per unit data

Vargo Electronics Company CVP Income Statement For the Month Ended June 30, 2020		
	Total	Per Unit
Sales (1,001 × \$500)	\$500,500	\$500
Variable costs (1,001 × \$300)	300,300	300
Contribution margin	200,200	\$200
Fixed costs	200,000	
Net income	\$ 200	

Contribution Margin Ratio

Some managers prefer to use a contribution margin ratio in CVP analysis. The contribution margin ratio is the contribution margin expressed as a percentage of sales. Vargo Electronics has a contribution margin ratio of 40% (contribution margin of \$200,200 divided by sales of \$500,500), as shown in the percent of sales column in **Illustration 22.16**.

Vargo Electronics Company CVP Income Statement For the Month Ended June 30, 2020		
	Total	Percent of Sales
Sales (1,000 × \$500)	\$500,500	100%
Variable costs (1,000 × \$300)	300,300	60
Contribution margin	200,200	40%
Fixed costs	200,000	
Net income	\$ 200	

ILLUSTRATION 22.16

CVP income statement, with net income and percent of sales data

Alternatively, the **contribution margin ratio** can be determined by dividing the unit contribution margin by the unit selling price. **Illustration 22.17** shows the ratio for Vargo Electronics.

Unit Contribution Margin	÷	Unit Selling Price	=	Contribution Margin Ratio
\$200	÷	\$500	=	40%

ILLUSTRATION 22.17

Formula for contribution margin ratio

The contribution margin ratio of 40% means that Vargo generates 40 cents of contribution margin with each dollar of sales. That is, \$0.40 of each sales dollar ($40\% \times \$1$) is available to apply to fixed costs and to contribute to net income.

This expression of contribution margin is very helpful in determining the effect of changes in sales on net income. For example, if Vargo's sales increase \$100,000, net income will increase \$40,000 ($40\% \times \$100,000$). Thus, by using the contribution margin ratio, managers can quickly determine increases in net income from any change in sales.

We can also see this effect through a CVP income statement. Assume that Vargo's current sales are \$500,000 and it wants to know the effect of a \$100,000 (200-unit) increase in sales. Vargo prepares the comparative CVP income statement analysis shown in **Illustration 22.18**.

ILLUSTRATION 22.18 Comparative CVP income statements

Vargo Electronics Company CVP Income Statement For the Month Ended June 30, 2020						
	No Change			With \$100,000 Increase in Sales		
	Total	Per Unit	Percent of Sales	Total	Per Unit	Percent of Sales
Sales	\$500,000	\$500	100%	\$600,000	\$500	100%
Variable costs	300,000	300	60	360,000	300	60
Contribution margin	200,000	\$200	40%	240,000	\$200	40%
Fixed costs	200,000			200,000		
Net income	\$ -0-			\$ 40,000		

The \$40,000 increase in net income can be calculated on either a unit contribution margin basis (200 units × \$200 per unit) or using the contribution margin ratio times the increase in sales dollars ($40\% \times \$100,000$). Note that the unit contribution margin and contribution

margin as a percentage of sales (that is, the contribution margin ratio) remain unchanged by the increase in sales.

Study these CVP income statements carefully. The concepts presented in these statements are used extensively in this and later chapters.

DO IT! 3 | CVP Income Statement

Ampco Industries produces and sells a cell phone-operated thermostat. Information regarding the costs and sales of thermostats during September 2020 are provided below.

Unit selling price of thermostat	\$85
Unit variable costs	\$32
Total monthly fixed costs	\$190,000
Units sold	4,000

Prepare a CVP income statement for Ampco Industries for the month of September. Provide per unit values and total values.

Solution

Ampco Industries
CVP Income Statement
For the Month Ended September 30, 2020

	<u>Total</u>	<u>Per Unit</u>
Sales	\$340,000	\$85
Variable costs	128,000	32
Contribution margin	212,000	\$53
Fixed costs	190,000	
Net income	<u>\$ 22,000</u>	

Related exercise material: **BE22.6**, **BE22.7**, **DO IT! 22.3**, and **E22.7**.

ACTION PLAN

- Provide a heading with the name of the company, name of statement, and period covered.
- Subtract variable costs from sales to determine contribution margin. Subtract fixed costs from contribution margin to determine net income.
- Express sales, variable costs and contribution margin on a per unit basis.

Break-Even Analysis

LEARNING OBJECTIVE 4

Compute the break-even point using three approaches.

A key relationship in CVP analysis is the level of activity at which total revenues equal total costs (both fixed and variable)—the **break-even point**. At this volume of sales, the company will realize no income but will suffer no loss. The process of finding the break-even point is called **break-even analysis**. Knowledge of the break-even point is useful to management when it considers decisions such as whether to introduce new product lines, change sales prices on established products, or enter new market areas.

The break-even point can be:

1. Computed from a mathematical equation.
2. Computed by using contribution margin.
3. Derived from a cost-volume-profit (CVP) graph.

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

Mathematical Equation

Illustration 22.19 shows a common profit equation used as the basis for CVP analysis. This equation expresses net income as sales minus variable and fixed costs. Sales is expressed as the unit selling price (\$500) times the number of units sold (Q). Variable costs are determined by multiplying the unit variable cost (\$300) by the number of units sold (Q). When net income is set to zero, as it is in this illustration, this equation can be used to calculate the break-even point.

Sales	–	Variable Costs	–	Fixed Costs	=	Net Income
\$500Q	–	\$300Q	–	\$200,000	=	\$0

ILLUSTRATION 22.19

Profit equation

As shown in Illustration 22.14, net income equals zero when the contribution margin (sales minus variable costs) is equal to fixed costs. To reflect this, **Illustration 22.20** rewrites the equation with contribution margin (sales minus variable costs) on the left side, and fixed costs and net income of zero on the right. We can then compute the break-even point **in units** by **using unit selling prices** and **unit variable costs** and solving for the quantity (Q).

Sales	–	Variable Costs	–	Fixed Costs	=	Net Income
\$500Q	–	\$300Q	–	\$200,000	=	\$0
\$500Q	–	\$300Q	=	\$200,000	+	\$0
\$200Q = \$200,000						
Q = $\frac{\$200,000}{\$200} = \frac{\text{Fixed Costs}}{\text{Unit Contribution Margin}}$						
Q = 1,000 units						
where						
Q = number of units sold						
\$500 = unit selling price						
\$300 = unit variable costs						
\$200,000 = total fixed costs						

ILLUSTRATION 22.20

Computation of break-even point in units

Thus, Vargo Electronics must sell 1,000 units to break even.

To find the amount of **sales dollars** required to break even, we multiply the units sold at the break-even point times the selling price per unit, as shown below.

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

Contribution Margin Technique

Many managers employ the contribution margin to compute the break-even point.

Contribution Margin in Units

The final step in Illustration 22.20 divides fixed costs by the unit contribution margin (highlighted in red). Thus, rather than walk through all of the steps of the equation approach, we can simply employ this formula shown in **Illustration 22.21**.

Fixed Costs	÷	Unit Contribution Margin	=	Break-Even Point in Units
\$200,000	÷	\$200	=	1,000 units

ILLUSTRATION 22.21

Formula for break-even point in units using unit contribution margin

Why does this formula work? The unit contribution margin is the net amount by which each sale exceeds the variable costs per unit. Every sale generates this much to cover fixed costs. Consequently, if we divide fixed costs by the unit contribution margin, we know how many units we need to sell to break even.

Contribution Margin Ratio

When a company has numerous products, it is not practical to determine the unit contribution margin for each product. In this case, using the contribution margin ratio is very useful for determining the break-even point in total dollars (rather than units). Recall that the contribution margin ratio is the percentage of each dollar of sales that is available to cover fixed costs and generate net income. Therefore, **to determine the sales dollars needed to cover fixed costs**, we divide fixed costs by the contribution margin ratio, as shown in **Illustration 22.22**.

ILLUSTRATION 22.22

Formula for break-even point in dollars using contribution margin ratio

Fixed Costs	÷	Contribution Margin Ratio	=	Break-Even Point in Dollars
\$200,000	÷	40%	=	\$500,000

To apply this formula to Vargo Electronics, consider that its 40% contribution margin ratio means that for every dollar sold, it generates 40 cents of contribution margin. The question is, how many dollars of sales does Vargo need in order to generate total contribution margin of \$200,000 to pay off fixed costs? We divide the fixed costs of \$200,000 by the 40 cents of contribution margin generated by each dollar of sales to arrive at \$500,000 (\$200,000 ÷ 40%). To prove this result, if we generate 40 cents of contribution margin for each dollar of sales, then the total contribution margin generated by \$500,000 in sales is \$200,000 (\$500,000 × 40%).

Service Company Insight Flightserve



Digital Vision/Getty Images

Charter Flights Offer a Good Deal

The Internet is wringing inefficiencies out of nearly every industry. While commercial aircraft spend roughly 4,000 hours a year in the air, chartered aircraft are flown only 500 hours annually. That means that they are sitting on the ground—not making any money—about 90% of the time.

One company, **Flightserve**, saw a business opportunity in that fact. For about the same cost as a first-class ticket, Flightserve matches up executives with charter flights in small “private jets.”

The executive gets a more comfortable ride and avoids the hassle of big airports. Flightserve noted that the average charter jet has eight seats. When all eight seats are full, the company has an 80% profit margin. It breaks even at an average of 3.3 full seats per flight. Another company, **NetJets**, uses an alternative approach to increase utilization of jets and thus reduce fixed costs. It offers shared ownership in private jets.

Sources: “Jet Set Go,” *The Economist* (March 18, 2000), p. 68; and Doug Gollan, “How NetJets’ Private Jet Service Is Making Itself Whole Again,” *Forbes* (June 3, 2015).

How did Flightserve determine that it would break even with 3.3 seats full per flight? (Go to WileyPLUS for this answer and additional questions.)

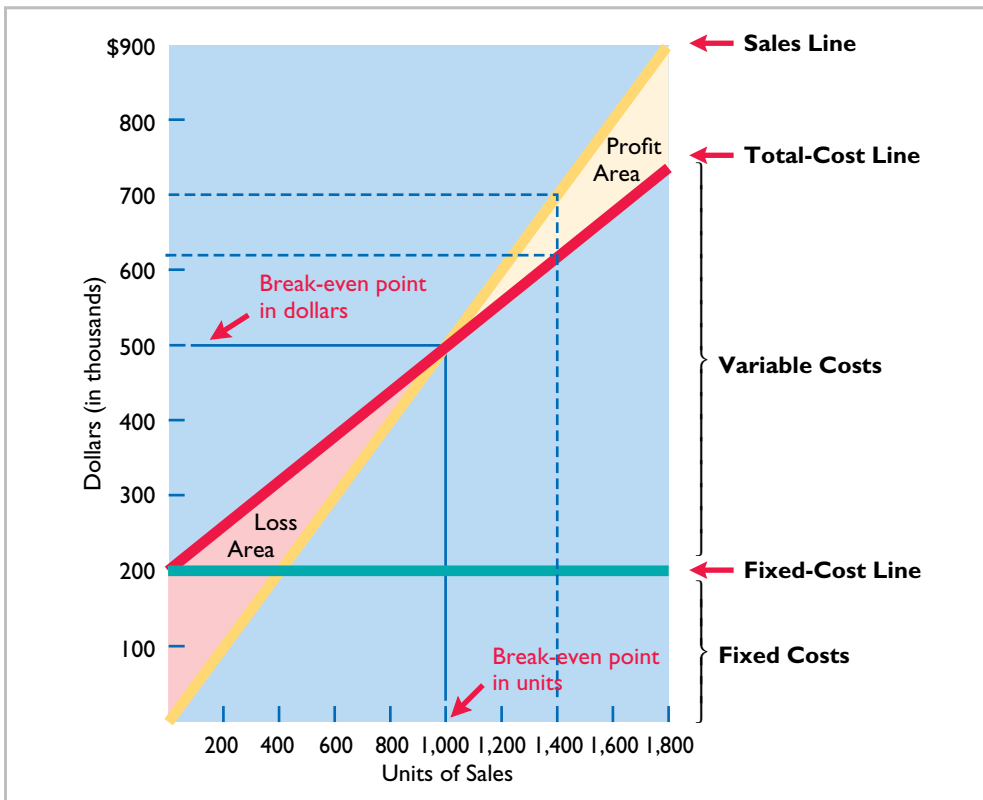
Graphic Presentation

An effective way to find the break-even point is to prepare a break-even graph. Because this graph also shows costs, volume, and profits, it is referred to as a **cost-volume-profit (CVP) graph**.

As the CVP graph in **Illustration 22.23** shows, sales volume is recorded along the horizontal axis. This axis should extend to the maximum level of expected sales. Both total revenues (sales) and total costs (fixed plus variable) are recorded on the vertical axis.

ILLUSTRATION 22.23

CVP graph



The construction of the graph, using the data for Vargo Electronics, is as follows.

1. Plot the sales line, starting at the zero activity level. For every cell phone sold, total revenue increases by \$500. For example, at 200 units, sales are \$100,000. At the upper level of activity (1,800 units), sales are \$900,000. The revenue line is assumed to be linear through the full range of activity.
2. Plot the total fixed costs using a horizontal line. For the cell phones, this line is plotted at \$200,000. The fixed costs are the same at every level of activity.
3. Plot the total-cost line. This starts at the fixed-cost line at zero activity. It increases by the variable costs at each level of activity. For each cell phone, variable costs are \$300. Thus, at 200 units, total variable costs are \$60,000 ($\300×200) and the total cost is \$260,000 ($\$60,000 + \$200,000$). At 1,800 units, total variable costs are \$540,000 ($\$300 \times 1,800$) and total cost is \$740,000 ($\$540,000 + \$200,000$). On the graph, the amount of the variable costs can be derived from the difference between the total-cost and fixed-cost lines at each level of activity.
4. Determine the break-even point from the intersection of the total-cost line and the sales line. The break-even point in dollars is found by drawing a horizontal line from the break-even point to the vertical axis. The break-even point in units is found by drawing a vertical line from the break-even point to the horizontal axis. For the cell phones, the break-even point is \$500,000 of sales, or 1,000 units. At this sales level, Vargo will cover costs but make no profit.

The CVP graph also shows both the net income and net loss areas. Thus, the amount of income or loss at each level of sales can be derived from the sales and total-cost lines.

A CVP graph is useful because the effects of a change in any element in the CVP analysis can be quickly seen. For example, a 10% increase in selling price will change the location of the sales line. Likewise, the effects on total costs of wage increases can be quickly observed.

DO IT! 4 | Break-Even Analysis

Lombardi Company has a unit selling price of \$400, variable costs per unit of \$240, and fixed costs of \$180,000. Compute the break-even point in units using (a) a mathematical equation and (b) unit contribution margin.

Solution

(a) The equation is $\$400Q - \$240Q - \$180,000 = \0 ; $(\$400Q - \$240Q) = \$180,000$. The break-even point in units is 1,125. (b) The unit contribution margin is \$160 ($\$400 - \240). The formula therefore is $\$180,000 \div \160 , and the break-even point in units is 1,125.

Related exercise material: **BE22.8, BE22.9, DO IT! 22.4, E22.8, E22.9, E22.10, E22.11, E22.12, and E22.13.**

ACTION PLAN

- Apply the profit equation: $\text{Sales} - \text{Variable costs} - \text{Fixed costs} = \text{Net income}$.
- Apply the break-even formula: $\text{Fixed costs} \div \text{Unit contribution margin} = \text{Break-even point in units}$.

Target Net Income and Margin of Safety

LEARNING OBJECTIVE 5

Determine the sales required to earn target net income and determine margin of safety.

Target Net Income

Rather than simply “breaking even,” management usually sets an income objective often called **target net income**. It then determines the sales necessary to achieve this specified level of income. Companies determine the sales necessary to achieve target net income by using one of the three approaches discussed earlier.

Mathematical Equation

We know that at the break-even point no profit or loss results for the company. By adding an amount for target net income to the same basic equation, we obtain the formula shown in **Illustration 22.24** for determining required sales.

ILLUSTRATION 22.24

Formula for sales to meet target net income

Sales	–	Variable Costs	–	Fixed Costs	=	Target Net Income
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Recall that once the break-even point has been reached so that fixed costs are covered, each additional unit sold increases net income by the amount of the unit contribution margin. We can rewrite the equation with contribution margin (sales minus variable costs) on the left-hand side, and fixed costs and target net income on the right. Assuming that target net income is \$120,000 for Vargo Electronics, the computation of required sales in units is as shown in **Illustration 22.25**.

ILLUSTRATION 22.25

Computation of required sales

Sales	–	Variable Costs	–	Fixed Costs	=	Target Net Income
\$500Q	–	\$300Q	–	\$200,000	=	\$120,000
\$500Q	–	\$300Q	=	\$200,000	+	\$120,000
\$200Q = \$200,000 + \$120,000						
$Q = \frac{\$200,000 + \$120,000}{\$200} = \frac{\text{Fixed Costs} + \text{Target Net Income}}{\text{Unit Contribution Margin}}$						
Q = 1,600						
where						
Q = number of units sold						
\$500 = unit selling price						
\$300 = unit variable costs						
\$200,000 = total fixed costs						
\$120,000 = target net income						

Vargo must sell 1,600 units to achieve target net income of \$120,000. The sales dollars required to achieve the target net income is found by multiplying the units sold by the unit selling price [(1,600 × \$500) = \$800,000].

Contribution Margin Technique

As in the case of break-even sales, we can compute in either units or dollars the sales required to meet target net income. The formula to compute required sales in units for Vargo Electronics using the unit contribution margin can be seen in the final step of the equation approach in Illustration 22.25 (shown in red). We simply divide the sum of fixed costs and target net income by the unit contribution margin. **Illustration 22.26** shows this for Vargo.

$\left(\begin{array}{c} \text{Fixed Costs} + \\ \text{Target Net Income} \end{array} \right)$	÷	Unit Contribution Margin	=	Sales in Units
(\$200,000 + \$120,000)	÷	\$200	=	1,600 units

ILLUSTRATION 22.26

Formula for sales in units using unit contribution margin

To achieve its desired target net income of \$120,000, Vargo must sell 1,600 cell phones.

Illustration 22.27 presents the formula to compute the required sales in dollars for Vargo using the contribution margin ratio.

$\left(\begin{array}{c} \text{Fixed Costs} + \\ \text{Target Net Income} \end{array} \right)$	÷	Contribution Margin Ratio	=	Sales in Dollars
(\$200,000 + \$120,000)	÷	40%	=	\$800,000

ILLUSTRATION 22.27

Formula for sales in dollars using contribution margin ratio

To achieve its desired target net income of \$120,000, Vargo must generate sales of \$800,000.

Graphic Presentation

We also can use the CVP graph in Illustration 22.23 to find the sales required to meet target net income. In the profit area of the graph, the distance between the sales line and the total-cost line at any point equals net income. We can find required sales by analyzing the differences between the two lines until the desired net income is found.

For example, suppose Vargo Electronics sells 1,400 cell phones. Illustration 22.23 shows that a vertical line drawn at 1,400 units intersects the sales line at \$700,000 and the total-cost line at \$620,000. The difference between the two amounts represents the net income (profit) of \$80,000.

Margin of Safety

Margin of safety is the difference between actual or expected sales and sales at the break-even point. It measures the “cushion” that a particular level of sales provides. It tells us how far sales could fall before the company begins operating at a loss. The margin of safety is expressed in dollars or as a ratio.

The formula for stating the **margin of safety in dollars** is actual (or expected) sales minus break-even sales. **Illustration 22.28** shows the computation for Vargo Electronics, assuming that actual (expected) sales are \$750,000.

ILLUSTRATION 22.28

Formula for margin of safety in dollars

Actual (Expected) Sales	–	Break-Even Sales	=	Margin of Safety in Dollars
\$750,000	–	\$500,000	=	\$250,000

Vargo’s margin of safety is \$250,000. Its sales could fall \$250,000 before it operates at a loss.

The **margin of safety ratio** is the margin of safety in dollars divided by actual (or expected) sales. **Illustration 22.29** shows the formula and computation for determining the margin of safety ratio.

ILLUSTRATION 22.29

Formula for margin of safety ratio

Margin of Safety in Dollars	÷	Actual (Expected) Sales	=	Margin of Safety Ratio
\$250,000	÷	\$750,000	=	33%

This means that the company’s sales could fall by 33% before it operates at a loss.

The higher the margin of safety in dollars or the percentage, the lower the risk that the company will operate at a loss. Management evaluates the adequacy of the margin of safety in terms of such factors as the vulnerability of the product to competitive pressures and to downturns in the economy.

Service Company Insight
Rolling Stones



Yael/Retna

How a Rolling Stones’ Tour Makes Money

Computations of break-even and margin of safety are important for service companies. Consider how the promoter for the **Rolling Stones’** tour used the break-even point and margin of safety. For example, say one outdoor show should bring 70,000 individuals for ticket sales of \$2.45 million. The promoter guarantees \$1.2 million to the

Rolling Stones. In addition, 20% of ticket sales goes to the stadium in which the performance is staged. Add another \$400,000 for other expenses such as ticket takers, parking attendants, advertising, and so on. The promoter also shares in sales of T-shirts and memorabilia for which the promoter will net over \$7 million during the tour. From a successful Rolling Stones’ tour, the promoter could make \$35 million!

What amount of sales dollars are required for the promoter to break even? (Go to WileyPLUS for this answer and additional questions.)

DO IT! 5 | Break-Even, Margin of Safety, and Target Net Income

Zootsuit Inc. makes travel bags that sell for \$56 each. For the coming year, management expects fixed costs to total \$320,000 and variable costs to be \$42 per unit. Compute the following: (a) break-even point in dollars using the contribution margin (CM) ratio; (b) the margin of safety and margin of safety ratio assuming actual sales are \$1,382,400; and (c) the sales dollars required to earn net income of \$410,000.

ACTION PLAN

- Apply the formula for the break-even point in dollars.
- Apply the formulas for the margin of safety in dollars and the margin of safety ratio.
- Apply the formula for the sales in dollars.

Solution

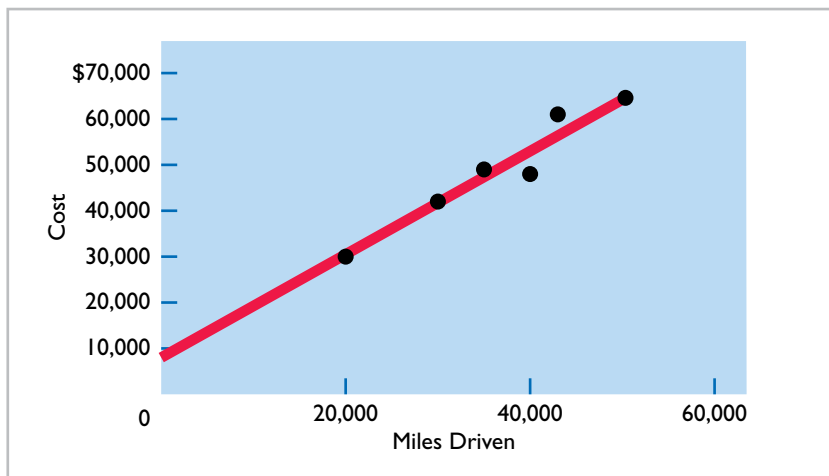
- a. Contribution margin ratio = $[(\$56 - \$42) \div \$56] = 25\%$
 Break-even sales in dollars = $\$320,000 \div 25\% = \$1,280,000$
- b. Margin of safety = $\$1,382,400 - \$1,280,000 = \$102,400$
 Margin of safety ratio = $\$102,400 \div \$1,382,400 = 7.4\%$
- c. Sales in dollars = $(\$320,000 + \$410,000) \div 25\% = \$2,920,000$

Related exercise material: **BE22.10, BE22.11, BE22.12, DO IT! 22.5, E22.14, E22.15, E22.16, and E22.17.**

Appendix 22A**Regression Analysis****LEARNING OBJECTIVE *6**

Describe how regression analysis is used to classify mixed costs.

The high-low method is often used to estimate fixed and variable costs for a mixed-cost situation. An advantage of the high-low method is that it is easy to apply. But, how accurate and reliable is the estimated cost equation that it produces? For example, consider the example shown in **Illustration 22A.1**, which indicates the cost equation line produced by the high-low method for Metro Transit Company's maintenance costs. How well does the high-low method represent the relationship between miles driven and total cost? This line is close to, and in some cases bisects, nearly all of the data points. Therefore, in this case, the high-low method provides a cost equation that is a very good fit for this data set. It identifies fixed and variable costs in an accurate and reliable way.

**ILLUSTRATION 22A.1**

Scatter plot for Metro Transit Company

While the high-low method works well for the Metro Transit data set, a weakness of this method is that it employs only two data points and ignores the rest. If those two data points are representative of the entire data set, then the high-low method provides reasonable results (as seen in Illustration 22A.1). But, if the high and low data points are not representative of the rest of the data set, then the results are misleading. To illustrate, assume that Hanson Trucking Company has 12 months of maintenance cost data, as shown in **Illustration 22A.2**.

ILLUSTRATION 22A.2**Maintenance costs and mileage data for Hanson Trucking Company**

Month	Miles Driven	Total Cost	Month	Miles Driven	Total Cost
January	20,000	\$30,000	July	15,000	\$39,000
February	40,000	49,000	August	28,000	41,000
March	35,000	46,000	September	60,000	72,000
April	50,000	63,000	October	55,000	67,000
May	30,000	42,000	November	19,000	29,000
June	43,000	52,000	December	65,000	63,000

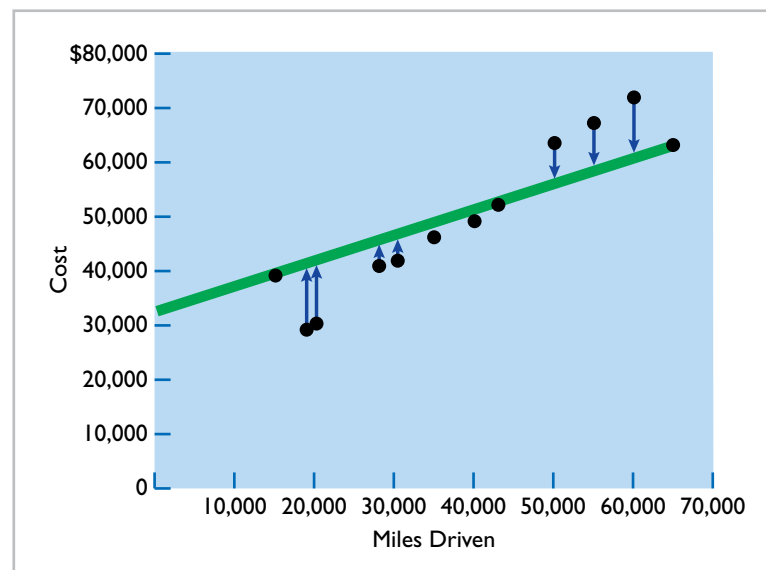
The high and low activities are 65,000 miles in December and 15,000 miles in July. The maintenance costs at these two levels are \$63,000 and \$39,000, respectively. The difference in maintenance costs is \$24,000 (\$63,000 – \$39,000), and the difference in miles is 50,000 (65,000 – 15,000). Therefore, for Hanson Trucking, variable cost per unit under the high-low method is \$0.48 (\$24,000 ÷ 50,000). To determine total variable cost, we multiply the number of miles by cost per mile. For example, at the low activity level of 15,000 miles, total variable cost is \$7,200 (15,000 × \$0.48). To determine fixed costs, we subtract total variable costs at the low activity level from the total cost at the low activity level (\$39,000) as follows.

$$\text{Fixed costs} = \$39,000 - (\$0.48 \times 15,000) = \$31,800$$

Therefore, the cost equation based on the high-low method for this data produces the following formula:

Maintenance costs	=	Intercept	+	Slope
	=	\$31,800	+	(\$0.48 × Miles driven)

Illustration 22A.3 shows a scatter plot of the data with a line representing the high-low method cost equation. Note that most of the data points for Hanson Trucking are a significant distance from the line. For example, at 19,000 miles, the observed maintenance cost is \$29,000, but the equation predicts \$40,920 [$\$31,800 + (\$0.48 \times 19,000)$]. That is a difference of \$11,920 (\$40,920 – \$29,000). In this case, the high-low method cost equation does not provide a good representation of the relationship between miles driven and maintenance costs. To derive a more representative cost equation, the company should employ regression analysis.

ILLUSTRATION 22A.3**Scatter plot for Hanson Trucking Company**

Regression analysis is a statistical approach that estimates the cost equation by employing information from all data points, not just the highest and lowest ones. While it involves mathematical analysis taught in statistics courses (which we will not address here), we can provide you with a basic understanding of how regression analysis works. Consider Illustration 22A.3, which highlights the distance that each data point is from the high-low cost equation line. What regression analysis does is to find a cost equation that results in a cost equation line that minimizes the sum of the (squared) distances from the line to the data points.

Many software packages perform regression analysis. In **Illustration 22A.4**, we use the **Intercept** and **Slope** functions in Excel to estimate the regression equation for the Hanson Trucking Company data.¹ The Excel video provided in WileyPLUS demonstrates the use of the Intercept and Slope functions.

Hanson Tracking				
Home Insert Page Layout Formulas Data Review View				
E2 fx				
	A	B	C	D
1	Month	Miles Driven	Total Cost	
2	January	20,000	30,000	
3	February	40,000	49,000	
4	March	35,000	46,000	
5	April	50,000	63,000	
6	May	30,000	42,000	
7	June	43,000	52,000	
8	July	15,000	39,000	
9	August	28,000	41,000	
10	September	60,000	72,000	
11	October	55,000	67,000	
12	November	19,000	29,000	
13	December	65,000	63,000	
14				
15		Formula		
16	Intercept	=INTERCEPT(C2:C13,B2:B13)	18,502	
17	Slope	=SLOPE(C2:C13,B2:B13)	0.81	
18				

ILLUSTRATION 22A.4

Excel spreadsheet for Hanson Trucking Company

The resulting cost equation is:

Maintenance costs	=	Intercept	+	Slope
	=	\$18,502	+	(\$0.81 × Miles driven)

Compare this to the high-low cost equation:

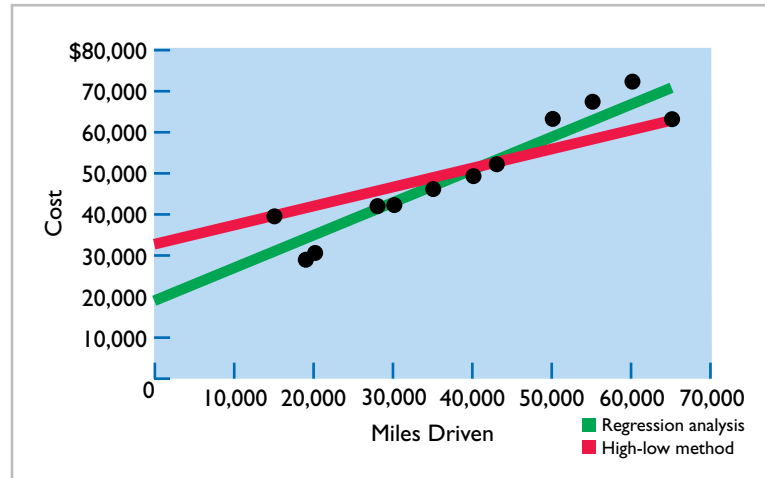
Maintenance costs	=	Intercept	+	Slope
	=	\$31,800	+	(\$0.48 × Miles driven)

¹ To use the Intercept and Slope functions in Excel, enter your data in two columns in an Excel spreadsheet. The first column should be your “X” variable (miles driven, cells B2 to B13 in our example). The second column should be your “Y” variable (maintenance costs, cells C2 to C13 in our example). Next, in a separate cell, choosing from Excel’s statistical functions, enter =Intercept(C2:C13,B2:B13) and in a different cell enter =Slope(C2:C13,B2:B13).

As **Illustration 22A.5** shows, the intercept and slope differ significantly between the regression equation (green) and the high-low equation (red).² The regression cost equation line does not bisect the high and low data points but instead follows a path that minimizes the cumulative distance from all of the data points. By doing so, it provides a cost equation that is more representative of the relationship between miles driven and total maintenance costs than the high-low method.

ILLUSTRATION 22A.5

Scatter plot and cost equation lines



Why should managers care about the accuracy of the cost equation? Managers make many decisions that require that mixed costs be separated into fixed and variable components. Inaccurate classifications of these costs might cause a manager to make an inappropriate decision. For example, Hanson Trucking Company's break-even point differs significantly depending on which of these two cost equations was used. If Hanson Trucking relies on the high-low method, it would have a distorted view of the level of sales it would need in order to break even. In addition, misrepresentation for fixed and variable costs could result in inappropriate decisions, such as whether to discontinue a product line. It would also result in inaccurate product costing under activity-based costing.

While regression analysis usually provides more reliable estimates of the cost equation, it does have its limitations.

1. The regression approach that we applied above assumes a linear relationship between the variables (that is, an increase or decrease in one variable results in a proportional increase or decrease in the other). If the actual relationship differs significantly from linearity, then linear regression can provide misleading results. (Nonlinear regression is addressed in advanced statistics courses.)
2. Regression estimates can be severely influenced by "outliers"—data points that differ significantly from the rest of the observations. It is therefore good practice to plot data points in a scatter graph to identify outliers and then investigate the reasons why they differ. In some cases, outliers must be adjusted for or eliminated.
3. Regression estimation is most accurate when it is based on a large number of data points. However, collecting data can be time-consuming and costly. In some cases, there simply are not enough observable data points to arrive at a reliable estimate.

² To plot a scatter graph in Excel, highlight the data and then click on Scatter under the Insert tab. To draw the cost equation line, click on the scatter plot, then select Layout and Trendline. In order to get the cost equation line to intercept the Y axis, under Trendline Options in the Backward field, enter the lowest value of your X variable. For example, for Hanson Trucking, we entered 15,000.

Review and Practice

Learning Objectives Review

1 Explain variable, fixed, and mixed costs and the relevant range.

Variable costs are costs that vary in total directly and proportionately with changes in the activity index. Fixed costs are costs that remain the same in total regardless of changes in the activity index.

The relevant range is the range of activity in which a company expects to operate during a year. It is important in CVP analysis because the behavior of costs is assumed to be linear throughout the relevant range.

Mixed costs change in total but not proportionately with changes in the activity level. For purposes of CVP analysis, mixed costs must be classified into their fixed and variable elements.

2 Apply the high-low method to determine the components of mixed costs.

Determine the variable costs per unit by dividing the change in total costs at the highest and lowest levels of activity by the difference in activity at those levels. Then, determine fixed costs by subtracting total variable costs from the amount of total costs at either the highest or lowest level of activity.

3 Prepare a CVP income statement to determine contribution margin.

The five components of CVP analysis are (1) volume or level of activity, (2) unit selling prices, (3) variable costs per unit, (4) total fixed costs, and (5) sales mix. Contribution margin is the amount of revenue remaining after deducting variable costs. It is identified in a CVP income statement, which classifies costs as variable or fixed. It can be expressed as a total amount, as a per unit amount, or as a ratio.

4 Compute the break-even point using three approaches.

The break-even point can be (a) computed from a mathematical equation, (b) computed by using a contribution margin technique, and (c) derived from a CVP graph.

5 Determine the sales required to earn target net income and determine margin of safety.

The general formula for required sales is $\text{Sales} - \text{Variable costs} - \text{Fixed costs} = \text{Target net income}$. Two other formulas are (1) $\text{Sales in units} = (\text{Fixed costs} + \text{Target net income}) \div \text{Unit contribution margin}$, and (2) $\text{Sales in dollars} = (\text{Fixed costs} + \text{Target net income}) \div \text{Contribution margin ratio}$.

Margin of safety is the difference between actual or expected sales and sales at the break-even point. The formulas for margin of safety are (1) $\text{Actual (expected) sales} - \text{Break-even sales} = \text{Margin of safety in dollars}$, and (2) $\text{Margin of safety in dollars} \div \text{Actual (expected) sales} = \text{Margin of safety ratio}$.

*6 Describe how regression analysis is used to classify mixed costs.

The high-low method provides a quick estimate of the cost equation for a mixed cost. However, the high-low method is based on only the highest and lowest data points. Regression analysis provides an estimate of the cost equation based on all data points. The cost equation line that results from regression analysis minimizes the sum of the (squared) distances of all of the data points from the cost equation line. Computer programs such as Excel enable easy estimation of the cost equation with regression.

Glossary Review

Activity index The activity that causes changes in the behavior of costs. (p. 22-3).

Break-even point The level of activity at which total revenue equals total costs. (p. 22-12).

Contribution margin (CM) The amount of revenue remaining after deducting variable costs. (p. 22-11).

Contribution margin ratio The percentage of each dollar of sales that is available to apply to fixed costs and contribute to net income; calculated as unit contribution margin divided by unit selling price. (p. 22-13).

Cost behavior analysis The study of how specific costs respond to changes in the level of business activity. (p. 22-2).

Cost-volume-profit (CVP) analysis The study of the effects of changes in costs and volume on a company's profits. (p. 22-10).

Cost-volume-profit (CVP) graph A graph showing the relationship between costs, volume, and profits. (p. 22-16).

Cost-volume-profit (CVP) income statement A statement for internal use that classifies costs as fixed or variable and reports contribution margin in the body of the statement. (p. 22-11).

Fixed costs Costs that remain the same in total regardless of changes in the activity level. (p. 22-3).

High-low method A mathematical method that uses the total costs incurred at the high and low levels of activity to classify mixed costs into fixed and variable components. (p. 22-7).

Margin of safety The difference between actual or expected sales and sales at the break-even point. (p. 22-20).

Mixed costs Costs that contain both a variable- and a fixed-cost element and change in total but not proportionately with changes in the activity level. (p. 22-6).

***Regression analysis** A statistical approach that estimates the cost equation by employing information from all data points to find the cost equation line that minimizes the sum of the squared distances from the line to the data points. (p. 22-23).

Relevant range The range of the activity index over which the company expects to operate during the year. (p. 22-5).

Target net income The income objective set by management. (p. 22-18).

Unit contribution margin The amount of revenue remaining per unit after deducting variable costs; calculated as unit selling price minus unit variable costs. (p. 22-12).

Variable costs Costs that vary in total directly and proportionately with changes in the activity level. (p. 22-3).

Practice Multiple-Choice Questions

1. (LO 1) 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.
2. (LO 2) 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.
3. (LO 1, 2) Mixed costs consist of a:
 - a. variable-cost element and a fixed-cost element.
 - b. fixed-cost element and a product-cost element.
 - c. period-cost element and a product-cost element.
 - d. variable-cost element and a period-cost element.
4. (LO 1, 2) Your cell phone service provider offers a plan that is classified as a mixed cost. The cost per month for 1,000 minutes is \$50. If you use 2,000 minutes this month, your cost will be:
 - a. \$50.
 - b. \$100.
 - c. more than \$100.
 - d. between \$50 and \$100.
5. (LO 2) Kendra Corporation's total utility costs during the past year were \$1,200 during its highest month and \$600 during its lowest month. These costs corresponded with 10,000 units of production during the high month and 2,000 units during the low month. What are the fixed and variable components of its utility costs using the high-low method?
 - a. \$0.075 variable and \$450 fixed.
 - b. \$0.120 variable and \$0 fixed.
 - c. \$0.300 variable and \$0 fixed.
 - d. \$0.060 variable and \$600 fixed.
6. (LO 3) Which of the following is **not** involved in CVP analysis?
 - a. Sales mix.
 - b. Unit selling prices.
 - c. Fixed costs per unit.
 - d. Volume or level of activity.
7. (LO 3) When comparing a traditional income statement to a CVP income statement:
 - a. net income will always be greater on the traditional statement.
 - b. net income will always be less on the traditional statement.
 - c. net income will always be identical on both.
 - d. net income will be greater or less depending on the sales volume.
8. (LO 3) Contribution margin:
 - a. is revenue remaining after deducting variable costs.
 - b. may be expressed as unit contribution margin.
 - c. is selling price less cost of goods sold.
 - d. Both (a) and (b) above.
9. (LO 3) Cournot Company sells 100,000 wrenches for \$12 a unit. Fixed costs are \$300,000, and net income is \$200,000. What should be reported as variable expenses in the CVP income statement?
 - a. \$700,000.
 - b. \$900,000.
 - c. \$500,000.
 - d. \$1,000,000.
10. (LO 4) 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.
11. (LO 4) Brownstone Company's contribution margin ratio is 30%. If Brownstone's sales revenue is \$100 greater than its break-even sales in dollars, its net income:
 - a. will be \$100.
 - b. will be \$70.
 - c. will be \$30.
 - d. cannot be determined without knowing fixed costs.
12. (LO 5) The mathematical equation for computing required sales to obtain target net income is 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.

13. (LO 5) Margin of safety is computed as:

- a. Actual sales – Break-even sales.
- b. Contribution margin – Fixed costs.
- c. Break-even sales – Variable costs.
- d. Actual sales – Contribution margin.

14. (LO 5) 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. 33⅓%.
- d. 45%.

Solutions

1. d. Variable costs vary in total directly and proportionately with changes in the activity level and remain the same per unit at every activity level. Choices (a) and (b) are correct, but (d) is the better and more complete answer. Since (a) and (b) are both true statements, choice (c) is incorrect.

2. c. The relevant range is the range over which the company expects to operate during a year. The other choices are incorrect because the relevant range is the range over which (a) variable costs are expected to be linear, not curvilinear, and (b) the company expects fixed costs to remain the same. Choice (d) is incorrect because this answer does not specifically define relevant range.

3. a. Mixed costs consist of a variable-cost element and a fixed-cost element, not (b) a product-cost element, (c) a period-cost element or a product-cost element, or (d) a period-cost element.

4. d. Your cost will include the fixed-cost component (flat service fee) which does not increase plus the variable cost (usage charge) for the additional 1,000 minutes which will increase your cost to between \$50 and \$100. Therefore, choices (a) \$50, (b) \$100, and (c) more than \$100 are incorrect.

5. a. Variable is \$0.075 $[(\$1,200 - \$600) \div (10,000 - 2,000)]$ and fixed is \$450 $[(\$1,200 - (\$0.075 \times 10,000))]$. Therefore, choices (b) \$0.120 variable and \$0 fixed, (c) \$0.300 variable and \$0 fixed, and (d) \$0.060 variable and \$600 fixed are incorrect.

6. c. Total fixed costs, not fixed costs per unit, are involved in CVP analysis. Choices (a) sales mix, (b) unit selling prices, and (d) volume or level of activity are all involved in CVP analysis.

7. c. Net income will always be identical on both a traditional income statement and a CVP income statement. Therefore, choices (a), (b), and (d) are incorrect statements.

8. d. Contribution margin is revenue remaining after deducting variable costs and it may be expressed on a per unit basis. Choices (a) and (b) are accurate, but (d) is a better answer. Choice (c) is incorrect because it defines gross margin, not contribution margin.

9. a. Contribution margin is equal to fixed costs plus net income $(\$300,000 + \$200,000 = \$500,000)$. Since variable expenses are the difference between total sales $(\$1,200,000)$ and contribution margin $(\$500,000)$, \$700,000 must be the amount of variable expenses in the CVP income statement. Therefore, choices (b) \$900,000, (c) \$500,000, and (d) \$1,000,000 are incorrect.

10. c. Unit contribution margin is \$1 $(\$4 \times 25\%)$. Fixed costs \div Unit contribution margin = Break-even point in units. Solving for fixed costs, $200,000 \text{ units} \times \$1 \text{ per unit} = \$200,000$, not (a) \$100,000, (b) \$160,000, or (d) \$300,000.

11. c. If Brownstone's sales revenue is \$100 greater than its break-even sales in dollars, its net income will be \$30 or $(\$100 \times 30\%)$, not (a) \$100 or (b) \$70. Choice (d) is incorrect because net income can be determined without knowing fixed costs.

12. b. The correct equation is Sales = Variable costs + Fixed costs + Target net income. The other choices are incorrect because (a) needs fixed costs added, (b) needs variable costs added, and (d) there is a correct answer given (b).

13. a. Margin of safety is computed as Actual sales – Break-even sales. Therefore, choices (b) Contribution margin – Fixed costs, (c) Break-even sales – Variable costs, and (d) Actual sales – Contribution margin are incorrect.

14. b. The margin of safety ratio is computed by dividing the margin of safety in dollars of \$180,000 $(\$600,000 - \$420,000)$ by actual sales of \$600,000. The result is 30% $(\$180,000 \div \$600,000)$, not (a) 25%, (c) 33⅓%, or (d) 45%.

Practice Brief Exercises

1. (LO 2) Benji Company accumulates the following data concerning a mixed cost, using miles as the activity level.

Determine variable- and fixed-cost elements using the high-low method.

	<u>Miles Driven</u>	<u>Total Cost</u>		<u>Miles Driven</u>	<u>Total Cost</u>
January	7,500	\$20,000	March	8,500	\$22,000
February	8,200	21,100	April	8,300	21,750

Compute the variable- and fixed-cost elements using the high-low method.

Solution

1.

<u>High</u>		<u>Low</u>		<u>Difference</u>
\$22,000	–	\$20,000	=	\$2,000
8,500	–	7,500	=	1,000

Variable cost per mile = $\$2,000 \div 1,000 = \2.00 .

	<u>High</u>	<u>Low</u>
Total cost	\$22,000	\$20,000
Less: Variable costs		
8,500 × \$2.00	17,000	
7,500 × \$2.00		15,000
Total fixed costs	<u>\$ 5,000</u>	<u>\$ 5,000</u>

Mixed cost is \$5,000 plus \$2.00 per mile.

Determine missing amounts for contribution margin.

2. (LO 3) Determine the missing amounts.

<u>Unit Selling Price</u>	<u>Unit Variable Costs</u>	<u>Unit Contribution Margin</u>	<u>Contribution Margin Ratio</u>
\$800	\$520	(a)	(b)
500	(c)	\$200	(d)
(e)	(f)	450	45%

Solution

2. a. $(\$800 - \$520) = \$280$
 b. $(\$280 \div \$800) = 35\%$
 c. $(\$500 - \$200) = \$300$
 d. $(\$200 \div \$500) = 40\%$
 e. $(\$450 \div 45\%) = \$1,000$
 f. $(\$1,000 - \$450) = \$550$

Compute the break-even point.

3. (LO 4) Jacob Company has a unit selling price of \$600, variable costs per unit of \$216, and fixed costs of \$2,438,400. Compute the break-even point in units using (a) the mathematical equation and (b) unit contribution margin.

Solution

3. a. $\$600Q - \$216Q - \$2,438,400 = \0
 $\$384Q = \$2,438,400$
 $Q = 6,350$ units
 b. Contribution margin per unit = $(\$600 - \$216) = \$384$
 Unit contribution margin = $\$2,438,400 \div \$384 = 6,350$ units

Compute the margin of safety and margin of safety ratio.

4. (LO 5) For Posh Company, actual sales are \$1,500,000, and break-even sales are \$1,300,000. Compute (a) the margin of safety in dollars and (b) the margin of safety ratio.

Solution

4. a. Margin of safety = $\$1,500,000 - \$1,300,000 = \$200,000$
 b. Margin of safety ratio = $\$200,000 \div \$1,500,000 = 13.3\%$

Practice Exercises

Determine fixed and variable costs using the high-low method and prepare graph.

1. (LO 1, 2) The controller of Teton Industries has collected the following monthly expense data for use in analyzing the cost behavior of maintenance costs.

<u>Month</u>	<u>Total Maintenance Costs</u>	<u>Total Machine Hours</u>
January	\$2,900	300
February	3,000	400
March	3,600	600
April	4,300	790
May	3,200	500
June	4,500	800

Instructions

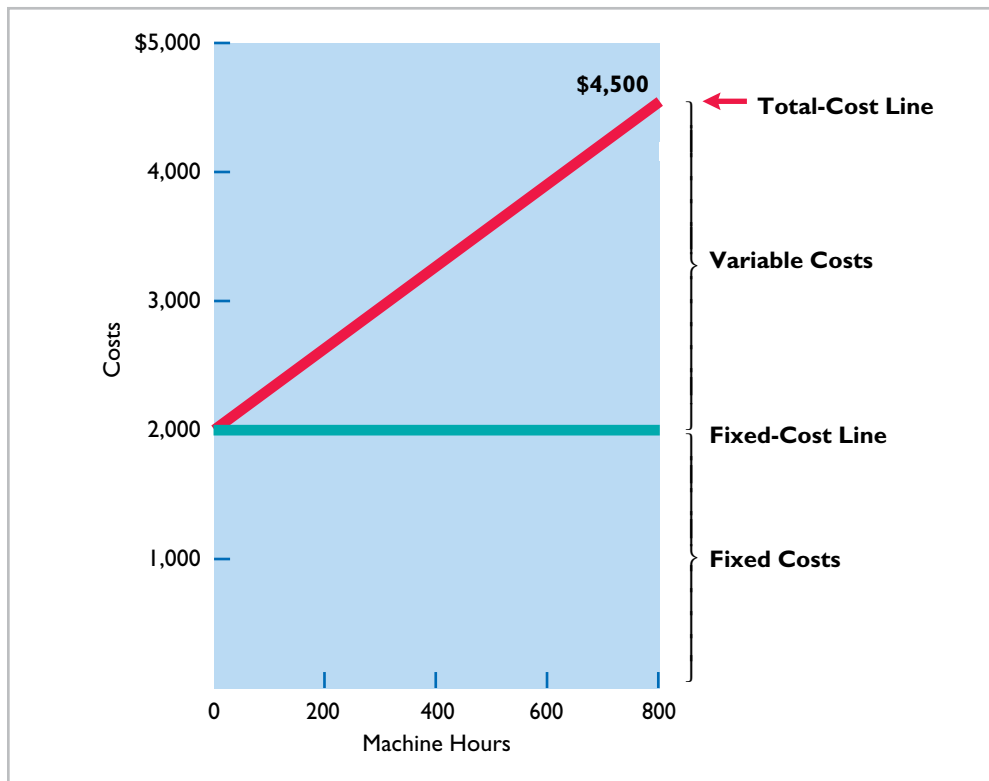
- Determine the fixed-cost and variable-cost components using the high-low method.
- Prepare a graph showing the behavior of maintenance costs, and identify the fixed-cost and variable-cost elements. Use 200 unit increments and \$1,000 cost increments.

Solution**1. a. Maintenance Costs:**

$$\frac{\$4,500 - \$2,900}{800 - 300} = \frac{\$1,600}{500} = \$3.20 \text{ variable cost per machine hour}$$

	<u>800</u> Machine Hours	<u>300</u> Machine Hours
Total costs	\$4,500	\$2,900
Less: Variable costs		
800 × \$3.20	2,560	
300 × \$3.20		960
Total fixed costs	<u>\$1,940</u>	<u>\$1,940</u>

Thus, maintenance costs are \$1,940 per month plus \$3.20 per machine hour.

b.**2. (LO 3, 4, 5)** Zion Seating Co., a manufacturer of chairs, had the following data for 2020:

Sales	2,400 units
Sales price	\$40 per unit
Variable costs	\$15 per unit
Fixed costs	\$19,500

Determine contribution margin ratio, break-even point in dollars, and margin of safety.

Instructions

- What is the contribution margin ratio?
- What is the break-even point in dollars?

- c. What is the margin of safety in dollars and the margin of safety ratio?
- d. If the company wishes to increase its total dollar contribution margin by 40% in 2021, by how much will it need to increase its sales if all other factors remain constant?

(CGA adapted)

Solution

- 2. a. Contribution margin ratio = Unit contribution margin ÷ Unit selling price
 $(\$40 - \$15) \div \$40 = 62.5\%$
- b. Break-even in dollars: $\$19,500 \div 62.5\% = \$31,200$
- c. Margin of safety in dollars = $(2,400 \times \$40) - \$31,200 = \$64,800$
 Margin of safety ratio = $\$64,800 \div (2,400 \times \$40) = 67.5\%$
- d. Current contribution margin is $\$40 - \$15 = \$25$
 Total contribution margin is $\$25 \times 2,400 = \$60,000$
 40% increase in contribution margin is $\$60,000 \times 40\% = \$24,000$
 Total increase in sales required is $\$24,000 \div 62.5\% = \$38,400$

Practice Problem

Compute break-even point, contribution margin ratio, margin of safety, and sales for target net income.

(LO 4, 5) Mabo Company makes calculators that sell for \$20 each. For the coming year, management expects fixed costs to total \$220,000 and variable costs to be \$9 per unit.

Instructions

- a. Compute break-even point in units using the mathematical equation.
- b. Compute break-even point in dollars using the contribution margin (CM) ratio.
- c. Compute the margin of safety percentage assuming actual sales are \$500,000.
- d. Compute the sales required in dollars to earn net income of \$165,000.

Solution

- a. Sales – Variable costs – Fixed costs = Net income
 $\$20Q - \$9Q - \$220,000 = \0
 $\$11Q = \$220,000$
 $Q = 20,000 \text{ units}$
- b. Unit contribution margin = Unit selling price – Unit variable costs
 $\$11 = \$20 - \$9$
 Contribution margin ratio = Unit contribution margin ÷ Unit selling price
 $55\% = \$11 \div \20
 Break-even point in dollars = Fixed costs ÷ Contribution margin ratio
 $= \$220,000 \div 55\%$
 $= \$400,000$
- c. Margin of safety = $\frac{\text{Actual sales} - \text{Break-even sales}}{\text{Actual sales}}$
 $= \frac{\$500,000 - \$400,000}{\$500,000}$
 $= 20\%$
- d. Sales – Variable costs – Fixed costs = Net income
 $\$20Q - \$9Q - \$220,000 = \$165,000$
 $\$11Q = \$385,000$
 $Q = 35,000 \text{ units}$
 $35,000 \text{ units} \times \$20 = \$700,000 \text{ required sales}$

OR

 (Fixed costs + Target net income) ÷ Contribution margin ratio = Sales in dollars
 $(\$220,000 + \$165,000) \div .55 = \$700,000$

WileyPLUS

Brief Exercises, DO IT! Exercises, Exercises, Problems, and many additional resources are available for practice in WileyPLUS.

Note: All asterisked Questions, Exercises, and Problems relate to material in the appendix to this chapter.

Questions

1. a. What is cost behavior analysis?
b. Why is cost behavior analysis important to management?
2. a. Scott Winter asks your help in understanding the term “activity index.” Explain the meaning and importance of this term for Scott.
b. State the two ways that variable costs may be defined.
3. Contrast the effects of changes in the activity level on total fixed costs and on unit fixed costs.
4. J. P. Alexander claims that the relevant range concept is important only for variable costs.
a. Explain the relevant range concept.
b. Do you agree with J. P.’s claim? Explain.
5. “The relevant range is indispensable in cost behavior analysis.” Is this true? Why or why not?
6. Adam Antal is confused. He does not understand why rent on his apartment is a fixed cost and rent on a Hertz rental truck is a mixed cost. Explain the difference to Adam.
7. How should mixed costs be classified in CVP analysis? What approach is used to effect the appropriate classification?
8. At the high and low levels of activity during the month, direct labor hours are 90,000 and 40,000, respectively. The related costs are \$165,000 and \$100,000. What are the fixed and variable costs at each level of activity?
9. “Cost-volume-profit (CVP) analysis is based entirely on unit costs.” Do you agree? Explain.
10. Faye Dunn defines contribution margin as the amount of profit available to cover operating expenses. Is there any truth in this definition? Discuss.
11. Marshall Company’s GWhiz calculator sells for \$40. Variable costs per unit are estimated to be \$26. What are the unit contribution margin and the contribution margin ratio?
12. “Break-even analysis is of limited use to management because a company cannot survive by just breaking even.” Do you agree? Explain.
13. Total fixed costs are \$26,000 for Daz Inc. It has a unit contribution margin of \$15, and a contribution margin ratio of 25%. Compute the break-even sales in dollars.
14. Peggy Turnbull asks your help in constructing a CVP graph. Explain to Peggy (a) how the break-even point is plotted, and (b) how the level of activity and dollar sales at the break-even point are determined.
15. Define the term “margin of safety.” If Revere Company expects to sell 1,250 units of its product at \$12 per unit, and break-even sales for the product are \$13,200, what is the margin of safety ratio?
16. Huang Company’s break-even sales are \$500,000. Assuming fixed costs are \$180,000, what sales volume is needed to achieve a target net income of \$90,000?
17. The traditional income statement for Pace Company shows sales \$900,000, cost of goods sold \$600,000, and operating expenses \$200,000. Assuming all costs and expenses are 70% variable and 30% fixed, prepare a CVP income statement through contribution margin.
- *18. James Brooks estimated the variable and fixed components of his company’s utility costs using the high-low method. He is concerned that the cost equation that resulted from the high-low method might not provide an accurate representation of his company’s utility costs. What is the inherent weakness of the high-low method? What alternative approach might Brooks use, and what are its advantages?
- *19. Mary Webster owns and manages a company that provides trenching services. Her clients are companies that need to lay power lines, gas lines, and fiber optic cable. Because trenching machines require considerable maintenance due to the demanding nature of the work, Mary has created a scatter plot that displays her monthly maintenance costs. If Mary were to estimate a cost equation line using regression analysis for the data in her scatter plot, what primary characteristic would that line display?
- *20. What are some of the limitations of regression analysis?

Brief Exercises

BE22.1 (LO 1) Monthly production costs in Dilts Company for two levels of production are as follows.

Cost	2,000 Units	4,000 Units
Indirect labor	\$10,000	\$20,000
Supervisory salaries	5,000	5,000
Maintenance	4,000	6,000

Classify costs as variable, fixed, or mixed.

Indicate which costs are variable, fixed, and mixed, and give the reason for each answer.

Diagram the behavior of costs within the relevant range.

BE22.2 (LO 1) For Lodes Company, the relevant range of production is 40–80% of capacity. At 40% of capacity, a variable cost is \$4,000 and a fixed cost is \$6,000. Diagram the behavior of each cost within the relevant range assuming the behavior is linear.

Diagram the behavior of a mixed cost.

BE22.3 (LO 1) For Wesland Company, a mixed cost is \$15,000 plus \$18 per direct labor hour. Diagram the behavior of the cost using increments of 500 hours up to 2,500 hours on the horizontal axis and increments of \$15,000 up to \$60,000 on the vertical axis.

Determine variable- and fixed-cost elements using the high-low method.

BE22.4 (LO 2) Bruno Company accumulates the following data concerning a mixed cost, using miles as the activity level.

	<u>Miles Driven</u>	<u>Total Cost</u>		<u>Miles Driven</u>	<u>Total Cost</u>
January	8,000	\$14,150	March	8,500	\$15,000
February	7,500	13,500	April	8,200	14,490

Compute the variable- and fixed-cost elements using the high-low method.

Determine variable- and fixed-cost elements using the high-low method.

BE22.5 (LO 2) Markowis Corp. has collected the following data concerning its maintenance costs for the past 6 months.

	<u>Units Produced</u>	<u>Total Cost</u>
July	18,000	\$36,000
August	32,000	48,000
September	36,000	55,000
October	22,000	38,000
November	40,000	74,500
December	38,000	62,000

Compute the variable- and fixed-cost elements using the high-low method.

Determine missing amounts for contribution margin.

BE22.6 (LO 3) Determine the missing amounts.

	<u>Unit Selling Price</u>	<u>Unit Variable Costs</u>	<u>Unit Contribution Margin</u>	<u>Contribution Margin Ratio</u>
1.	\$640	\$352	(a)	(b)
2.	\$300	(c)	\$93	(d)
3.	(e)	(f)	\$325	25%

Prepare CVP income statement.

BE22.7 (LO 3) Russell Inc. had sales of \$2,200,000 for the first quarter of 2020. In making the sales, the company incurred the following costs and expenses.

	<u>Variable</u>	<u>Fixed</u>
Cost of goods sold	\$920,000	\$440,000
Selling expenses	70,000	45,000
Administrative expenses	86,000	98,000

Prepare a CVP income statement for the quarter ended March 31, 2020.

Compute the break-even point.

BE22.8 (LO 4) Rice Company has a unit selling price of \$520, variable costs per unit of \$286, and fixed costs of \$163,800. Compute the break-even point in units using (a) the mathematical equation and (b) unit contribution margin.

Compute the break-even point.

BE22.9 (LO 4) Presto Corp. had total variable costs of \$180,000, total fixed costs of \$110,000, and total revenues of \$300,000. Compute the required sales in dollars to break even.

Compute sales for target net income.

BE22.10 (LO 5) For Flynn Company, variable costs are 70% of sales, and fixed costs are \$195,000. Management's net income goal is \$75,000. Compute the required sales in dollars needed to achieve management's target net income of \$75,000. (Use the contribution margin approach.)

Compute the margin of safety and the margin of safety ratio.

BE22.11 (LO 5) For Astoria Company, actual sales are \$1,000,000, and break-even sales are \$800,000. Compute (a) the margin of safety in dollars and (b) the margin of safety ratio.

Compute the required sales in units for target net income.

BE22.12 (LO 5) Deines Corporation has fixed costs of \$480,000. It has a unit selling price of \$6, unit variable costs of \$4.40, and a target net income of \$1,500,000. Compute the required sales in units to achieve its target net income.

***BE22.13 (LO 6)** Data for Stiever Corporation's maintenance costs is shown below.

Compute variable and fixed cost elements using regression.

	<u>Units Produced</u>	<u>Total Cost</u>
July	18,000	\$32,000
August	32,000	48,000
September	36,000	55,000
October	22,000	38,000
November	40,000	66,100
December	38,000	62,000

Compute the variable- and fixed-cost elements using regression analysis. Present your solution in the form of a cost equation. (We recommend that you use the Intercept and Slope functions in Excel.)

DO IT! Exercises

DO IT! 22.1 (LO 1) Amanda Company reports the following total costs at two levels of production.

Classify types of costs.

	<u>5,000 Units</u>	<u>10,000 Units</u>
Indirect labor	\$ 3,000	\$ 6,000
Property taxes	7,000	7,000
Direct labor	28,000	56,000
Direct materials	22,000	44,000
Depreciation	4,000	4,000
Utilities	5,000	8,000
Maintenance	9,000	11,000

Classify each cost as variable, fixed, or mixed.

DO IT! 22.2 (LO 2) Westerville Company accumulates the following data concerning a mixed cost, using units produced as the activity level.

Compute costs using high-low method and estimate total cost.

	<u>Units Produced</u>	<u>Total Cost</u>
March	10,000	\$18,000
April	9,000	16,650
May	10,500	18,580
June	8,800	16,200
July	9,500	17,100

- Compute the variable- and fixed-cost elements using the high-low method.
- Using the information from your answer to part (a), write the cost formula.
- Estimate the total cost if the company produces 9,200 units.

DO IT! 22.3 (LO 3) Cedar Grove Industries produces and sells a cell phone-operated home security control. Information regarding the costs and sales of security controls during May 2020 are provided below.

Prepare CVP income statement.

Unit selling price of security control	\$45
Unit variable costs	\$22
Total monthly fixed costs	\$120,000
Units sold	8,000

Prepare a CVP income statement for Cedar Grove Industries for the month of May. Provide per unit values and total values.

DO IT! 22.4 (LO 4) Snow Cap Company has a unit selling price of \$250, variable costs per unit of \$170, and fixed costs of \$160,000. Compute the break-even point in units using (a) the mathematical equation and (b) unit contribution margin.

Compute break-even point in units.

Compute break-even point, margin of safety ratio, and sales for target net income.

DO IT! 22.5 (LO 5) Presto Company makes radios that sell for \$30 each. For the coming year, management expects fixed costs to total \$220,000 and variable costs to be \$18 per unit.

- Compute the break-even point in dollars using the contribution margin (CM) ratio.
- Compute the margin of safety ratio assuming actual sales are \$800,000.
- Compute the sales dollars required to earn net income of \$140,000.

Exercises

Define and classify variable, fixed, and mixed costs.

E22.1 (LO 1) Bonita Company manufactures a single product. Annual production costs incurred in the manufacturing process are shown below for two levels of production.

Production in Units	Costs Incurred			
	5,000		10,000	
Production Costs	Total Cost	Cost/Unit	Total Cost	Cost/Unit
Direct materials	\$8,000	\$1.60	\$16,000	\$1.60
Direct labor	9,500	1.90	19,000	1.90
Utilities	2,000	0.40	3,300	0.33
Rent	4,000	0.80	4,000	0.40
Maintenance	800	0.16	1,400	0.14
Supervisory salaries	1,000	0.20	1,000	0.10

Instructions

- Define the terms variable costs, fixed costs, and mixed costs.
- Classify each cost above as either variable, fixed, or mixed.

Diagram cost behavior, determine relevant range, and classify costs.

E22.2 (LO 1) Shingle Enterprises is considering manufacturing a new product. It projects the cost of direct materials and rent for a range of output as shown below.

Output in Units	Rent Expense	Direct Materials
1,000	\$ 5,000	\$ 4,000
2,000	5,000	7,200
3,000	8,000	9,000
4,000	8,000	12,000
5,000	8,000	15,000
6,000	8,000	18,000
7,000	8,000	21,000
8,000	8,000	24,000
9,000	10,000	29,300
10,000	10,000	35,000
11,000	10,000	44,000

Instructions

- Diagram the behavior of each cost for output ranging from 1,000 to 11,000 units.
- Determine the relevant range of activity for this product.
- Calculate the variable costs per unit within the relevant range.
- Indicate the fixed cost within the relevant range.

Determine fixed and variable costs using the high-low method and prepare graph.

E22.3 (LO 1, 2) The controller of Norton Industries has collected the following monthly expense data for use in analyzing the cost behavior of maintenance costs.

Month	Total Maintenance Costs	Total Machine Hours
January	\$2,700	300
February	3,000	350
March	3,600	500
April	4,500	690
May	3,200	400
June	5,500	700

Instructions

- Determine the fixed- and variable-cost components using the high-low method.
- Prepare a graph showing the behavior of maintenance costs, and identify the fixed- and variable-cost elements. Use 100-hour increments and \$1,000 cost increments.

E22.4 (LO 1) Family Furniture Corporation incurred the following costs.

- Wood used in the production of furniture.
- Fuel used in delivery trucks.
- Straight-line depreciation on factory building.
- Screws used in the production of furniture.
- Sales staff salaries.
- Sales commissions.
- Property taxes.
- Insurance on buildings.
- Hourly wages of furniture craftsmen.
- Salaries of factory supervisors.
- Utilities expense.
- Telephone bill.

Classify variable, fixed, and mixed costs.

Instructions

Identify the costs above as variable, fixed, or mixed.

E22.5 (LO 1, 2) The controller of Hall Industries has collected the following monthly expense data for use in analyzing the cost behavior of maintenance costs.

Determine fixed and variable costs using the high-low method and prepare graph.

<u>Month</u>	<u>Total Maintenance Costs</u>	<u>Total Machine Hours</u>
January	\$2,640	3,500
February	3,000	4,000
March	3,600	6,000
April	4,500	7,900
May	3,200	5,000
June	4,620	8,000

Instructions

- Determine the fixed- and variable-cost components using the high-low method.
- Prepare a graph showing the behavior of maintenance costs and identify the fixed- and variable-cost elements. Use 2,000-hour increments and \$1,000 cost increments.

E22.6 (LO 1) PCB Corporation manufactures a single product. Monthly production costs incurred in the manufacturing process are shown below for the production of 3,000 units. The utilities and maintenance costs are mixed costs. The fixed portions of these costs are \$300 and \$200, respectively.

Determine fixed, variable, and mixed costs.

<u>Production in Units</u>	<u>3,000</u>
<u>Production Costs</u>	
Direct materials	\$ 7,500
Direct labor	18,000
Utilities	2,100
Property taxes	1,000
Indirect labor	4,500
Supervisory salaries	1,900
Maintenance	1,100
Depreciation	2,400

Instructions

- Identify the above costs as variable, fixed, or mixed.
- Calculate the expected costs when production is 5,000 units.

E22.7 (LO 3) Writing Marty Moser wants Moser Company to use CVP analysis to study the effects of changes in costs and volume on the company. Marty has heard that certain assumptions must be valid in order for CVP analysis to be useful.

Explain assumptions underlying CVP analysis.

Instructions

Prepare a memo to Marty Moser concerning the assumptions that underlie CVP analysis.

Compute break-even point in units and dollars.

E22.8 (LO 3, 4) Service All That Blooms provides environmentally friendly lawn services for homeowners. Its operating costs are as follows.

Depreciation	\$1,400 per month
Advertising	\$200 per month
Insurance	\$2,000 per month
Weed and feed materials	\$12 per lawn
Direct labor	\$10 per lawn
Fuel	\$2 per lawn

All That Blooms charges \$60 per treatment for the average single-family lawn.

Instructions

Determine the company's break-even point in (a) number of lawns serviced per month and (b) dollars.

Compute break-even point.



E22.9 (LO 3, 4) Service The Palmer Acres Inn is trying to determine its break-even point during its off-peak season. The inn has 50 rooms that it rents at \$60 a night. Operating costs are as follows.

Salaries	\$5,900 per month
Utilities	\$1,100 per month
Depreciation	\$1,000 per month
Maintenance	\$100 per month
Maid service	\$14 per room
Other costs	\$28 per room

Instructions

Determine the inn's break-even point in (a) number of rented rooms per month and (b) dollars.

Compute contribution margin and break-even point.

E22.10 (LO 3, 4) Service In the month of March, Style Salon services 560 clients at an average price of \$120. During the month, fixed costs were \$21,024 and variable costs were 60% of sales.

Instructions

- Determine the total contribution margin in dollars, the per unit contribution margin, and the contribution margin ratio.
- Using the contribution margin technique, compute the break-even point in dollars and in units.

Compute break-even point.

E22.11 (LO 3, 4) Service Spencer Kars provides shuttle service between four hotels near a medical center and an international airport. Spencer Kars uses two 10-passenger vans to offer 12 round trips per day. A recent month's activity in the form of a cost-volume-profit income statement is shown below.

Sales (1,500 passengers)		\$36,000
Variable costs		
Fuel	\$ 5,040	
Tolls and parking	3,100	
Maintenance	860	9,000
		<hr/>
Contribution margin		27,000
Fixed costs		
Salaries	15,700	
Depreciation	1,300	
Insurance	1,000	18,000
		<hr/>
Net income		\$ 9,000
		<hr/>

Instructions

- Calculate the break-even point in (1) dollars and (2) number of passengers.
- Without calculations, determine the contribution margin at the break-even point.

Compute variable costs per unit, contribution margin ratio, and increase in fixed costs.

E22.12 (LO 3, 4) In 2019, Manhoff Company had a break-even point of \$350,000 based on a selling price of \$5 per unit and fixed costs of \$112,000. In 2020, the selling price and the variable costs per unit did not change, but the break-even point increased to \$420,000.

Instructions

- Compute the variable costs per unit and the contribution margin ratio for 2019.
- Compute the increase in fixed costs for 2020.

E22.13 (LO 3, 4) Billings Company has the following information available for September 2020.

Prepare CVP income statements.

Unit selling price of video game consoles	\$ 400
Unit variable costs	\$ 280
Total fixed costs	\$54,000
Units sold	600

Instructions

- Compute the unit contribution margin.
- Prepare a CVP income statement that shows both total and per unit amounts.
- Compute Billings' break-even point in units.
- Prepare a CVP income statement for the break-even point that shows both total and per unit amounts.

E22.14 (LO 4, 5) Naylor Company had \$210,000 of net income in 2019 when the selling price per unit was \$150, the variable costs per unit were \$90, and the fixed costs were \$570,000. Management expects per unit data and total fixed costs to remain the same in 2020. The president of Naylor Company is under pressure from stockholders to increase net income by \$52,000 in 2020.

Compute various components to derive target net income under different assumptions.

Instructions

- Compute the number of units sold in 2019.
- Compute the number of units that would have to be sold in 2020 to reach the stockholders' desired profit level.
- Assume that Naylor Company sells the same number of units in 2020 as it did in 2019. What would the selling price have to be in order to reach the stockholders' desired profit level?

E22.15 (LO 5) Yams Company reports the following operating results for the month of August: sales \$400,000 (units 5,000), variable costs \$240,000, and fixed costs \$90,000. Management is considering the following independent courses of action to increase net income.

Compute net income under different alternatives.

- Increase selling price by 10% with no change in total variable costs or units sold.
- Reduce variable costs to 55% of sales.

Instructions

Compute the net income to be earned under each alternative. Which course of action will produce the higher net income?

E22.16 (LO 4, 5) Glacial Company estimates that variable costs will be 62.5% of sales, and fixed costs will total \$600,000. The selling price of the product is \$4.

Prepare a CVP graph and compute break-even point and margin of safety.

Instructions

- Compute the break-even point in (1) units and (2) dollars.
- Prepare a CVP graph, assuming maximum sales of \$3,200,000. (Note: Use \$400,000 increments for sales and costs and 100,000 increments for units.)
- Assuming actual sales are \$2 million, compute the margin of safety in (1) dollars and (2) as a ratio.

E22.17 (LO 3, 4, 5) Felde Bucket Co., a manufacturer of rain barrels, had the following data for 2019:

Determine contribution margin ratio, break-even point in dollars, and margin of safety.

Sales	2,500 units
Sales price	\$40 per unit
Variable costs	\$24 per unit
Fixed costs	\$19,500

Instructions

- What is the contribution margin ratio?
- What is the break-even point in dollars?
- What is the margin of safety in dollars and as a ratio?
- If the company wishes to increase its total dollar contribution margin by 30% in 2020, by how much will it need to increase its sales if all other factors remain constant?

(CGA adapted)

Determine cost components using regression, prepare scatter plot, and estimate cost at particular level of activity.

***E22.18 (LO 6)** The controller of Standard Industries has collected the following monthly expense data for analyzing the cost behavior of electricity costs.

	<u>Total Electricity Costs</u>	<u>Total Machine Hours</u>
January	\$2,500	300
February	3,000	350
March	3,600	500
April	4,500	690
May	3,200	400
June	4,900	700
July	4,100	650
August	3,800	520
September	5,100	680
October	4,200	630
November	3,300	350
December	6,100	720

Instructions

- Determine the fixed- and variable-cost components using regression analysis (We recommend the use of Excel.)
- Prepare a scatter plot using Excel. Present the cost equation line estimated in part (a).
- What electricity cost does the cost equation estimate for a level of activity of 500 machine hours? By what amount does this differ from March's observed cost for 500 machine hours?

Problems: Set A

Determine cost components using high-low method, and estimate cost at particular level of activity.

P22.1A (LO 1, 2) The controller of Rather Production has collected the following monthly expense data for analyzing the cost behavior of electricity costs.

	<u>Total Electricity Costs</u>	<u>Total Machine Hours</u>
January	\$2,500	300
February	3,000	350
March	3,600	500
April	4,500	690
May	3,200	400
June	4,900	700
July	4,100	650
August	3,800	520
September	5,100	680
October	4,200	630
November	3,300	350
December	5,860	720

Instructions

- Determine the fixed- and variable-cost components using the high-low method.
- What electricity cost does the cost equation estimate for a level of activity of 500 machine hours? By what amount does this differ from March's observed cost for 500 machine hours?
- What electricity cost does the cost equation estimate for a level of activity of 700 machine hours? By what amount does this differ from June's observed cost for 700 machine hours?

Determine variable and fixed costs, compute break-even point, prepare a CVP graph, and determine net income.

P22.2A (LO 1, 2, 3, 4) Service Vin Diesel owns the Fredonia Barber Shop. He employs four barbers and pays each a base rate of \$1,250 per month. One of the barbers serves as the manager and receives an extra \$500 per month. In addition to the base rate, each barber also receives a commission of \$4.50 per haircut.

Other costs are as follows.

Advertising	\$200 per month
Rent	\$1,100 per month
Barber supplies	\$0.30 per haircut
Utilities	\$175 per month plus \$0.20 per haircut
Magazines	\$25 per month

Vin currently charges \$10 per haircut.

Instructions

- Determine the variable costs per haircut and the total monthly fixed costs.
- Compute the break-even point in units and dollars.
- Prepare a CVP graph, assuming a maximum of 1,800 haircuts in a month. Use increments of 300 haircuts on the horizontal axis and \$3,000 on the vertical axis.
- Determine net income, assuming 1,600 haircuts are given in a month.

a. VC \$5

P22.3A (LO 3, 4, 5) Jorge Company bottles and distributes B-Lite, a diet soft drink. The beverage is sold for 50 cents per 16-ounce bottle to retailers. For the year 2020, management estimates the following revenues and costs.

Sales	\$1,800,000	Selling expenses—variable	\$70,000
Direct materials	430,000	Selling expenses—fixed	65,000
Direct labor	360,000	Administrative expenses—variable	20,000
Manufacturing overhead—variable	380,000	Administrative expenses—fixed	60,000
Manufacturing overhead—fixed	280,000		

Prepare a CVP income statement, compute break-even point, contribution margin ratio, margin of safety ratio, and sales for target net income.



Instructions

- Prepare a CVP income statement for 2020 based on management's estimates. (Show column for total amounts only.)
- Compute the break-even point in (1) units and (2) dollars.
- Compute the contribution margin ratio and the margin of safety ratio. (Round to nearest full percent.)
- Determine the sales dollars required to earn net income of \$180,000.

b. (1) 2,700,000 units

c. CM ratio 30%

P22.4A (LO 4) Tanek Corp.'s sales slumped badly in 2020. For the first time in its history, it operated at a loss. The company's income statement showed the following results from selling 500,000 units of product: sales \$2,500,000, total costs and expenses \$2,600,000, and net loss \$100,000. Costs and expenses consisted of the amounts shown below.

Compute break-even point under alternative courses of action.

	<u>Total</u>	<u>Variable</u>	<u>Fixed</u>
Cost of goods sold	\$2,140,000	\$1,590,000	\$550,000
Selling expenses	250,000	92,000	158,000
Administrative expenses	210,000	68,000	142,000
	<u>\$2,600,000</u>	<u>\$1,750,000</u>	<u>\$850,000</u>

Management is considering the following independent alternatives for 2021.

- Increase unit selling price 20% with no change in costs, expenses, and sales volume.
- Change the compensation of salespersons from fixed annual salaries totaling \$150,000 to total salaries of \$60,000 plus a 5% commission on sales.

Instructions

- Compute the break-even point in dollars for 2020.
- Compute the break-even point in dollars under each of the alternative courses of action. (Round all ratios to nearest full percent.) Which course of action do you recommend?

b. Alternative 1 \$2,023,810

P22.5A (LO 3, 4, 5) Mary Willis is the advertising manager for Bargain Shoe Store. She is currently working on a major promotional campaign. Her ideas include the installation of a new lighting system and increased display space that will add \$24,000 in fixed costs to the \$270,000 currently spent. In addition, Mary is proposing that a 5% price decrease (\$40 to \$38) will produce a 20% increase in sales volume (20,000 to 24,000). Variable costs will remain at \$24 per pair of shoes. Management is impressed

Compute break-even point and margin of safety ratio, and prepare a CVP income statement before and after changes in business environment.

with Mary's ideas but concerned about the effects that these changes will have on the break-even point and the margin of safety.

Instructions

- b. Current margin of safety ratio 16%

Compute contribution margin, fixed costs, break-even point, sales for target net income, and margin of safety ratio.

- Compute the current break-even point in units, and compare it to the break-even point in units if Mary's ideas are used.
- Compute the margin of safety ratio for current operations and after Mary's changes are introduced. (Round to nearest full percent.)
- Prepare a CVP income statement for current operations and after Mary's changes are introduced. (Show column for total amounts only.) Would you make the changes suggested?

P22.6A (LO 3, 4, 5) Viejol Corporation has collected the following information after its first year of sales. Sales were \$1,600,000 on 100,000 units, selling expenses \$250,000 (40% variable and 60% fixed), direct materials \$490,000, direct labor \$290,000, administrative expenses \$270,000 (20% variable and 80% fixed), and manufacturing overhead \$380,000 (70% variable and 30% fixed). Top management has asked you to do a CVP analysis so that it can make plans for the coming year. It has projected that unit sales will increase by 10% next year.

Instructions

- b. 120,000 units

- Compute (1) the contribution margin for the current year and the projected year, and (2) the fixed costs for the current year. (Assume that fixed costs will remain the same in the projected year.)
- Compute the break-even point in units and sales dollars for the current year.
- The company has a target net income of \$200,000. What is the required sales in dollars for the company to meet its target?
- If the company meets its target net income number, by what percentage could its sales fall before it is operating at a loss? That is, what is its margin of safety ratio?

Determine variable and fixed costs.

P22.7A (LO 1, 3, 5) Kaiser Industries carries no inventories. Its product is manufactured only when a customer's order is received. It is then shipped immediately after it is made. For its fiscal year ended October 31, 2020, Kaiser's break-even point was \$1.3 million. On sales of \$1.2 million, its income statement showed a gross profit of \$180,000, direct materials cost of \$400,000, and direct labor costs of \$500,000. The contribution margin was \$144,000, and variable manufacturing overhead was \$50,000.

Instructions

- a. 2. \$70,000

- Calculate the following:
 - Variable selling and administrative expenses.
 - Fixed manufacturing overhead.
 - Fixed selling and administrative expenses.
- Ignoring your answer to part (a), assume that fixed manufacturing overhead was \$100,000 and the fixed selling and administrative expenses were \$80,000. The marketing vice president feels that if the company increased its advertising, sales could be increased by 25%. What is the maximum increased advertising cost the company can incur and still report the same income as before the advertising expenditure?

(CGA adapted)

Continuing Cases



Current Designs

CD22 Bill Johnson, sales manager, and Diane Buswell, controller, at Current Designs are beginning to analyze the cost considerations for one of the composite models of the kayak division. They have provided the following production and operational costs necessary to produce one composite kayak.

Current Designs				
Home Insert Page Layout Formulas Data Review View				
B7 fx				
	A	B	C	
1	Kevlar®	\$250 per kayak		
2	Resin and supplies	\$100 per kayak		
3	Finishing kit (seat, rudder, ropes, etc.)	\$170 per kayak		
4	Labor	\$420 per kayak		
5	Selling and administrative expenses—variable	\$400 per kayak		
6	Selling and administrative expenses—fixed	\$119,700 per year		
7	Manufacturing overhead—fixed	\$240,000 per year		
8				

Bill and Diane have asked you to provide a cost-volume-profit analysis, to help them finalize the budget projections for the upcoming year. Bill has informed you that the selling price of the composite kayak will be \$2,000.

Instructions

- Calculate variable costs per unit.
- Determine the unit contribution margin.
- Using the unit contribution margin, determine the break-even point in units for this product line.
- Assume that Current Designs plans to earn net income of \$270,600 on this product line. Using the unit contribution margin, calculate the number of units that need to be sold to achieve this goal.
- Based on the most recent sales forecast, Current Designs plans to sell 1,000 units of this model. Using your results from part (c), calculate the margin of safety and the margin of safety ratio.

Waterways

(Note: This is a continuation of the Waterways case from Chapters 19–21.)

WP22 The Vice President for Sales and Marketing at Waterways Corporation is planning for production needs to meet sales demand in the coming year. He is also trying to determine how the company's profits might be increased in the coming year. This problem asks you to use cost-volume-profit concepts to help Waterways understand contribution margins of some of its products and decide whether to mass-produce any of them.

Go to **WileyPLUS** for complete case details and instructions.

Expand Your Critical Thinking

Decision-Making Across the Organization

CT22.1 Creative Ideas Company has decided to introduce a new product. The new product can be manufactured by either a capital-intensive method or a labor-intensive method. The manufacturing method will not affect the quality of the product. The estimated manufacturing costs by the two methods are as follows.

	Capital-Intensive	Labor-Intensive
Direct materials	\$5 per unit	\$5.50 per unit
Direct labor	\$6 per unit	\$8.00 per unit
Variable overhead	\$3 per unit	\$4.50 per unit
Fixed manufacturing costs	\$2,524,000	\$1,550,000

Creative Ideas' market research department has recommended an introductory unit sales price of \$32. The incremental selling expenses are estimated to be \$502,000 annually plus \$2 for each unit sold, regardless of manufacturing method.

Instructions

With the class divided into groups, answer the following.

- Calculate the estimated break-even point in annual unit sales of the new product if Creative Ideas Company uses the:
 - Capital-intensive manufacturing method.
 - Labor-intensive manufacturing method.
- Determine the annual unit sales volume at which Creative Ideas Company would be indifferent between the two manufacturing methods.
- Explain the circumstance under which Creative Ideas should employ each of the two manufacturing methods.

(CMA adapted)

Managerial Analysis

CT22.2 The condensed income statement for the Peri and Paul partnership for 2020 is as follows.

Peri and Paul Company		
Income Statement		
For the Year Ended December 31, 2020		
Sales (240,000 units)		\$1,200,000
Cost of goods sold		<u>800,000</u>
Gross profit		400,000
Operating expenses		
Selling	\$280,000	
Administrative	<u>150,000</u>	<u>430,000</u>
Net loss		<u>\$ (30,000)</u>

A cost behavior analysis indicates that 75% of the cost of goods sold are variable, 42% of the selling expenses are variable, and 40% of the administrative expenses are variable.

Instructions

(Round to nearest unit, dollar, and percentage, where necessary. Use the CVP income statement format in computing profits.)

- Compute the break-even point in total sales dollars and in units for 2020.
- Peri has proposed a plan to get the partnership “out of the red” and improve its profitability. She feels that the quality of the product could be substantially improved by spending \$0.25 more per unit on better raw materials. The selling price per unit could be increased to only \$5.25 because of competitive pressures. Peri estimates that sales volume will increase by 25%. What effect would Peri’s plan have on the profits and the break-even point in dollars of the partnership? (Round the contribution margin ratio to two decimal places.)
- Paul was a marketing major in college. He believes that sales volume can be increased only by intensive advertising and promotional campaigns. He therefore proposed the following plan as an alternative to Peri’s: (1) increase variable selling expenses to \$0.59 per unit, (2) lower the selling price per unit by \$0.25, and (3) increase fixed selling expenses by \$40,000. Paul quoted an old marketing research report that said that sales volume would increase by 60% if these changes were made. What effect would Paul’s plan have on the profits and the break-even point in dollars of the partnership?
- Which plan should be accepted? Explain your answer.

Real-World Focus

CT22.3 The Coca-Cola Company hardly needs an introduction. A line taken from the cover of a recent annual report says it all: If you measured time in servings of Coca-Cola, “a billion Coca-Cola’s ago was yesterday morning.” On average, every U.S. citizen drinks 363 8-ounce servings of Coca-Cola products each year. Coca-Cola’s primary line of business is the making and selling of syrup to bottlers. These bottlers then sell the finished bottles and cans of Coca-Cola to the consumer.

In the annual report of Coca-Cola, the information shown below was provided.

The Coca-Cola Company Management Discussion

Our gross margin declined to 61 percent this year from 62 percent in the prior year, primarily due to costs for materials such as sweeteners and packaging.

The increases [in selling expenses] in the last two years were primarily due to higher marketing expenditures in support of our Company's volume growth.

We measure our sales volume in two ways: (1) gallon shipments of concentrates and syrups and (2) unit cases of finished product (bottles and cans of Coke sold by bottlers).

Instructions

Answer the following questions.

- a. Are sweeteners and packaging a variable cost or a fixed cost? What is the impact on the contribution margin of an increase in the per unit cost of sweeteners or packaging? What are the implications for profitability?
- b. In your opinion, are Coca-Cola's marketing expenditures a fixed cost, variable cost, or mixed cost? Give justification for your answer.
- c. Which of the two measures cited for measuring volume represents the activity index as defined in this chapter? Why might Coca-Cola use two different measures?

Communication Activity

CT22.4 Your roommate asks for your help on the following questions about CVP analysis formulas.

- a. How can the mathematical equation for break-even sales show both sales units and sales dollars?
- b. How do the formulas differ for unit contribution margin and contribution margin ratio?
- c. How can contribution margin be used to determine break-even sales in units and in dollars?

Instructions

Write a memo to your roommate stating the relevant formulas and answering each question.

Ethics Case

CT22.5 Scott Bestor is an accountant for Westfield Company. Early this year, Scott made a highly favorable projection of sales and profits over the next 3 years for Westfield's hot-selling computer PLEX. As a result of the projections Scott presented to senior management, the company decided to expand production in this area. This decision led to dislocations of some plant personnel who were reassigned to one of the company's newer plants in another state. However, no one was fired, and in fact the company expanded its workforce slightly.

Unfortunately, Scott rechecked his projection computations a few months later and found that he had made an error that would have reduced his projections substantially. Luckily, sales of PLEX have exceeded projections so far, and management is satisfied with its decision. Scott, however, is not sure what to do. Should he confess his honest mistake and jeopardize his possible promotion? He suspects that no one will catch the error because PLEX sales have exceeded his projections, and it appears that profits will materialize close to his projections.

Instructions

- a. Who are the stakeholders in this situation?
- b. Identify the ethical issues involved in this situation.
- c. What are the possible alternative actions for Scott? What would you do in Scott's position?

All About You

CT22.6 Cost-volume-profit analysis can also be used in making personal financial decisions. For example, the purchase of a new car is one of your biggest personal expenditures. It is important that you carefully analyze your options.

Suppose that you are considering the purchase of a hybrid vehicle. Let's assume the following facts. The hybrid will initially cost an additional \$4,500 above the cost of a traditional vehicle. The hybrid will get 40 miles per gallon of gas, and the traditional car will get 30 miles per gallon. Also, assume that the cost of gas is \$3.60 per gallon.

Instructions

Using the facts above, answer the following questions.

- a. What is the variable gasoline cost of going one mile in the hybrid car? What is the variable cost of going one mile in the traditional car?
- b. Using the information in part (a), if "miles" is your unit of measure, what is the "contribution margin" of the hybrid vehicle relative to the traditional vehicle? That is, express the variable cost savings on a per-mile basis.
- c. How many miles would you have to drive in order to break even on your investment in the hybrid car?
- d. What other factors might you want to consider?