

Module 16

Cost-Volume-Profit Analysis and Planning

Learning Objectives

- LO1** Describe the uses and limitations of traditional cost-volume-profit analysis. (p. 16-3)
- LO2** Prepare and contrast contribution and functional income statements. (p. 16-7)
- LO3** Apply cost-volume-profit analysis to find a break-even point and for preliminary profit planning. (p. 16-9)
- LO4** Analyze the profitability and sales mix of a multiple-product firm. (p. 16-15)
- LO5** Apply operating leverage ratio to assess opportunities for profit and the risks of loss. (p. 16-19)
- LO6** Perform profitability analysis with unit and nonunit cost drivers (Appendix 16A). (p. 16-21)

Razor USA, LLC

www.razor.com

Based in Cerritos, California, **Razor USA, LLC** designs and manufactures an array of rideable devices ranging from kick scooters to self-balancing hoverboards. Razor, as it is commonly known, was founded in 2000 and has experienced tremendous growth. Razor's first product, the model A kick scooter, sold over 5 million units within six months of its introduction and won the 2000 Toy of The Year award. By 2010, Razor had sold over 35 million scooters. Razor built on its kick scooter success and expanded its product line to include electric scooters, a modern version of the Scream Machine™, go-karts, electric motor bikes, and self-balancing hoverboards.

Razor is redefining the "ride on" category of toys and is well positioned for continued success, but how much should it charge for its products? How many units does Razor need to sell to breakeven? How many units does it need to sell to reach its target profit? These are questions that managers within Razor must answer.

Profitability analysis involves examining the relations between revenues, costs, and profits. Performing profitability analysis requires an understanding of selling prices and the behavior of activity cost drivers. Profitability analysis is widely used to make better decisions regarding existing or proposed products or services. Typically, it is performed before decisions are finalized in the operating budget for a future period.

If Razor is to accomplish its goals, it must generate profits, meaning that its revenues must exceed its costs. Razor's manufacturing processes consume energy and raw materials. The price of these inputs changes over time. By decomposing Razor's costs into its variable and fixed components, the company can perform profitability analyses to determine where to direct its future efforts. In fact, Razor can utilize the tools presented in this module to determine how much revenue it has to generate to achieve a desired profit.

This module introduces basic approaches to profitability analysis and planning. We consider single product, multiple-product, and service organizations; income taxes; sales mix; and the effects of cost structure on the relation between profit potential and the risk of loss.



Road Map

LO	Learning Objective Topics	Page	eLecture	Guided Example	Assignments
16-1					
16-2					
16-3					
16-4					
16-5					
16-6					



What fee should we charge for a subscription to our services? How many units do we need to sell to break even? How many units do we need to sell to reach our target profit?

Profitability analysis involves examining the relationships among revenues, costs, and profits. Performing profitability analysis requires an understanding of selling prices and the behavior of activity cost drivers. Profitability analysis is widely used to make better decisions regarding existing or proposed products or services. Typically, it is performed before decisions are finalized in the operating budget for a future period.

This module introduces basic approaches to profitability analysis and planning. We consider single-product, multiple-product, and service organizations; income taxes; sales mix; and the effects of cost structure on the relation between profit potential and the risk of loss.

Lectures

MBC Describe the uses and limitations of traditional cost-volume-profit analysis.

Cost-volume-profit (CVP) analysis is a technique used to examine the relationships among the total volume of an independent variable, total costs, total revenues, and profits for a time period (typically a quarter or year). With CVP analysis, volume refers to a single activity cost driver, such as unit sales, that is assumed to correlate with changes in revenues, costs, and profits.

Cost-volume-profit analysis is useful in the early stages of planning because it provides an easily understood framework for discussing planning issues and organizing relevant data. CVP analysis is widely used by for-profit as well as not-for-profit organizations. It is equally applicable to service, merchandising, and manufacturing firms.

In for-profit organizations, CVP analysis is used to answer such questions as these: How many photocopies must the local **Staples** store produce to earn a profit of \$80,000? At what dollar sales volume will **Whole Foods'** total revenues and total costs be equal? What profit will **Target** earn at

an annual sales volume of \$75 billion? What will happen to the profit of **Panera Bread** if there is a 20 percent increase in the cost of food and a 10 percent increase in the selling price of meals? The Research Insight box at the bottom of this page indicates how the role of managerial accounting is expanding. With greater availability of data, managers can efficiently perform more analyses to help guide CVP decisions.

In not-for-profit organizations, CVP analysis is used to establish service levels, plan fund-raising activities, and determine funding requirements. How many meals can the downtown **Salvation Army** serve with an annual budget of \$600,000? How many tickets must be sold for the benefit concert to raise \$20,000? Given the current cost structure, current tuition rates, and projected enrollments, how much money must **DePaul University** raise from other sources?

Key Assumptions

CVP analysis is subject to a number of assumptions. Although these assumptions do not negate the usefulness of CVP models, especially for a single product or service, they do suggest the need for further analysis before plans are finalized. Among the more important assumptions are:

1. *All costs are classified as fixed or variable.* This assumption is most reasonable when analyzing the profitability of a specific event (such as a concert) or the profitability of an organization that produces a single product or service on a continuous basis.
2. *The total cost function is linear within the relevant range.* This assumption is often valid within a relevant range of normal operations, but over the entire range of possible activity, changes in efficiency are likely to result in a nonlinear cost function.
3. *The total revenue function is linear within the relevant range.* Unit selling prices are assumed constant over the range of possible volumes. This implies a purely competitive market for final products or services. In some economic models in which demand responds to price changes, the revenue function is nonlinear. In these situations, the linear approximation is accurate only within a limited range of activity.
4. *The analysis is for a single product, or the sales mix of multiple products is constant.* The **sales mix** refers to the relative portion of unit or dollar sales derived from each product or service. If products have different selling prices and costs, changes in the mix affect CVP model results.
5. *There is only one cost driver: unit or sales dollar volume.* In a complex organization it is seldom possible to represent the multitude of factors that drive cost with a single cost driver.

Research Insight ■ Data-Driven Planning Central to Management Accounting

The role of management accounting is expanding to include planning driven by data science. This work is often called financial planning and analysis (FP&A) and is used widely enough that a professional accrediting program has been launched by the **Association for Financial Professionals (AFP)**.

The central function of the FP&A group within a company is to inform decisions with data. **GoDaddy Inc.** called on its FP&A group to help guide the domain-name seller's international expansion. The team developed purpose-built growth metrics to help executives allocate marketing dollars across the 40 countries where GoDaddy does business. By finding the correct metric to drive resource decisions, GoDaddy was able to increase the share of sales from foreign markets to 26% of total sales. Its CFO claims that the FP&A group's contribution tripled foreign growth.

At **Dunkin Brands Group Inc.**, the FP&A group has influence in every department, helping managers and employees across the organization find ways to improve processes and practices. Dunkin's 36-member FP&A team took on the key job of mining loyalty data to find ways to get customers back into the store throughout the day and increasing the amount that the customers spent. This effort led to a 2.2% growth in same-store sales over nine months.

While Dunkin is deeply committed to FP&A (its CFO was the VP of FP&A), other firms are adopting this approach more slowly. The consulting firm CEB notes that 61% of FP&A directors do not feel that top managers take their contributions seriously. As this perception changes, accountants trained in management accounting principles will have the chance to influence companies with their analyses.

Source: Alix Stuart, "Metrics Sell Doughnuts and More," *Wall Street Journal*, December 21, 2015.

Profitability at **Whole Foods** has come from cultivating customers who are willing to pay higher prices for high-quality organic groceries. **Trader Joe's** has shown that there is a market for lower-cost organic groceries, but Whole Foods is facing its stiffest competition from **Aldi**. Owned by the same parent company as Trader Joe's, Aldi offers the quality and sustainability of Whole Foods at much lower prices.

The German chain is able to lower prices by dramatically reducing overhead. Aldi stores can be run by as few as four employees, because every detail of the shopping experience is designed to empower the customer to shop without help. Aldi also focuses its product line on one or two high-quality options per product to reduce inventory costs and store size.

Whole Foods has taken notice of the demand for a simpler and lower-cost grocery experience. 365, a new grocery store open in select locations, is Whole Foods' response to this new type of store. 365 mimics many of Aldi's methods for reducing overhead. But 365 adds a coffee/wine/beer shop and cafe designed to make the store a more frequent stop in patrons' routines. It remains to be seen whether Whole Foods can simultaneously manage these two businesses with such different cost structures.

Sources: Joel Stein, "Whole Foods Is Getting Killed by Aldi. Is a Millennial Grocery Chain the Fix?" *Bloomberg Businessweek*, June 20, 2016.

Leslie Patton, "Aldi Tries High-End Food and Discounts, Too," *Bloomberg Businessweek*, August 6, 2015.

When applied to a single product (such as pounds of potato chips), service (such as the number of pages printed), or event (such as the number of tickets sold to a banquet), it is reasonable to assume the single independent variable is the cost driver. The total costs associated with the single product, service, or event during a specific time period are often determined by this single activity cost driver.

Although cost-volume-profit analysis is often used to understand the overall operations of an organization or business segment, accuracy decreases as the scope of operations being analyzed increases.

Profit Formula

The profit associated with a product, service, or event is equal to the difference between total revenues and total costs as follows:

$$\pi = R - Y$$

where

$$\pi = \text{Profit}$$

$$R = \text{Total revenues}$$

$$Y = \text{Total costs}$$

The revenues are a function of the unit sales volume and the unit selling price, while total costs for a time period are a function of the fixed costs per period and the unit variable costs as follows:

$$R = pX$$

$$Y = a + bX$$

where

$$p = \text{Unit selling price}$$

$$a = \text{Fixed costs}$$

$$b = \text{Unit variable costs}$$

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

The equation for profit can then be expanded to include the above details of the total revenue and total cost equations as follows:

$$\pi = pX - (a + bX)$$

Using information on the selling price, fixed costs per period, and variable costs per unit, this formula is used to predict profit at any specified activity level.

To illustrate, assume that **Razor's** only product is a standard kick scooter that it manufactures and sells to merchandisers at \$60 per completed scooter. Applying inventory minimization techniques, Razor does not maintain inventories of raw materials or finished goods. Instead, newly purchased raw materials

are delivered directly to the factory, and finished goods are loaded directly onto trucks for shipment. Razor's variable and fixed costs follow.

1. **Direct materials** refer to the cost of the primary raw materials converted into finished goods. Because the consumption of raw materials increases as the quantity of goods produced increases, *direct materials represents a variable cost*. Razor's raw materials consist primarily of nuts and bolts, rubber wheels, bearings, steel frames, and packaging materials. Razor also treats the costs of purchasing, receiving, and inspecting these materials as part of the cost of direct materials. Assume that all together, these costs are \$20 per completed scooter.
2. **Direct labor** refers to wages earned by production employees for the time they spend working on the conversion of raw materials into finished goods. Based on Razor's manufacturing procedures, *direct labor represents a variable cost*. Further assume these costs are \$10 per completed scooter.
3. **Variable manufacturing overhead** includes all other variable costs associated with converting raw materials into finished goods. Assume Razor's variable manufacturing overhead costs include the costs of lubricants for cutting and packaging machines, electricity to operate these machines, and the cost to move materials between receiving and shipping. These costs are \$3 per completed scooter.
4. **Variable selling and administrative costs** include all variable costs other than those directly associated with converting raw materials into finished goods. Assume at Razor, these costs include sales commissions and transportation of finished goods to merchandisers. These costs are \$5 per completed scooter.
5. **Fixed manufacturing overhead** includes all fixed costs associated with converting raw materials into finished goods. Suppose Razor's fixed manufacturing costs include the depreciation, property taxes, and insurance on buildings and machines used for manufacturing, the salaries of manufacturing supervisors, and the fixed portion of electricity used to light the factory. Further assume these costs are \$35,000 per month.
6. **Fixed selling and administrative costs** include all fixed costs other than those directly associated with converting raw materials into finished goods. These costs include the salaries of Razor's divisional manager and many other staff personnel such as accounting and marketing. Also included are depreciation, property taxes, insurance on facilities used for administrative purposes, and any related utilities costs. Assume these costs are \$15,000 per month.

Razor's hypothetical variable and fixed costs are summarized here.



Variable Costs per Scooter		Fixed Costs per Month	
Manufacturing		Manufacturing overhead	\$35,000
Direct materials.....	\$20	Selling and administrative	15,000
Direct labor.....	10	Total	<u><u>\$50,000</u></u>
Manufacturing overhead	3		
Selling and administrative			
Total	<u><u>\$38</u></u>		

The cost estimation techniques discussed in Module 15 can be used to determine many detailed costs. Least-squares regression, for example, might be used to determine the variable and monthly fixed amount of electricity used in manufacturing. Assume Razor manufactures and sells a single product on a continuous basis with all sales to merchandisers under standing contracts. Therefore, it is reasonable to assume that in the short run, Razor's total monthly costs respond to a single cost driver, scooters sold. Combining all this information, Razor's profit equation is assumed to be:

$$\text{Profit} = \$60X - (\$50,000 + \$38X)$$

where

X = scooters sold

Using this equation, Razor's profit at a volume of 5,400 units is \$68,800, computed as $(\$60 \times 5,400) - [\$50,000 + (\$38 \times 5,400)]$.

Review 16-1 LO1



Benchmark Paper Company's only product is high-quality photocopy paper that it manufactures and sells to wholesale distributors at \$14 per carton. Applying inventory minimization techniques, Benchmark does not maintain inventories of raw materials or finished goods. Newly purchased raw materials are delivered directly to the factory, and finished goods are loaded directly onto trucks for shipment. Benchmark's variable and fixed costs follow:

Variable Costs per Carton		Fixed Costs per Month	
Manufacturing		Manufacturing overhead.....	\$ 2,000
Direct materials.....	\$1.25	Selling and administrative	<u>8,000</u>
Direct labor.....	0.50	Total	<u>\$10,000</u>
Manufacturing overhead	<u>2.50</u>		
Selling and administrative	<u>1.00</u>		
Total	<u>\$5.25</u>		

Required

- a. Determine Benchmark's profit equation.

Solution on p. 16-37. b. Using your equation, calculate Benchmark's profit at a volume of 6,200 cartons.

Contribution and Functional Income Statements



LO2
Prepare and contrast contribution and functional income statements.

Contribution Income Statement

To provide more detailed information on anticipated or actual financial results at a particular sales volume, a contribution income statement is often prepared. Razor's hypothetical contribution income statement for a volume of 5,400 units is in Exhibit 16.1. In a **contribution income statement**, costs are classified according to behavior as variable or fixed, and the **contribution margin** (the difference between total revenues and total variable costs) that goes toward covering fixed costs and providing a profit is emphasized.

Exhibit 16.1 ■ Contribution Income Statement

RAZOR COMPANY Contribution Income Statement For a Monthly Volume of 5,400 Scooters		
Sales (5,400 × \$60).....		\$324,000
Less variable costs		
Direct materials (5,400 × \$20).....	\$108,000	
Direct labor (5,400 × \$10)	54,000	
Manufacturing overhead (5,400 × \$3).....	16,200	
Selling and administrative (5,400 × \$5).....	<u>27,000</u>	<u>(205,200)</u>
Contribution margin.....		118,800
Less fixed costs		
Manufacturing overhead	35,000	
Selling and administrative	<u>15,000</u>	<u>(50,000)</u>
Profit.....		<u>\$ 68,800</u>

Functional Income Statement

Contrast the contribution income statement in Exhibit 16.1 with Razor's hypothetical income statement in Exhibit 16.2. This statement is called a **functional income statement** because costs are classified according to function (rather than behavior), such as manufacturing, selling, and administrative. This is the type of income statement typically included in corporate annual reports.

A problem with a functional income statement is the difficulty of relating it to the profit formula in which costs are classified according to behavior rather than function. The relationship between sales volume, costs, and profits is not readily apparent in a functional income statement. Consequently, we emphasize contribution income statements because they provide better information to internal decision makers.

Exhibit 16.2 ■ Functional Income Statement

RAZOR COMPANY Functional Income Statement For a Monthly Volume of 5,400 Cartons		
Sales (5,400 × \$60)		\$324,000
Less cost of goods sold		
Direct materials (5,400 × \$20)	\$108,000	
Direct labor (5,400 × \$10)	54,000	
Variable manufacturing overhead (5,400 × \$3)	16,200	
Fixed manufacturing overhead.....	35,000	(213,200)
Gross margin		110,800
Less other expenses		
Variable selling and administrative (5,400 × \$5)	27,000	
Fixed selling and administrative.....	15,000	(42,000)
Profit.....		\$ 68,800

Analysis Using Contribution Margin Ratio

While the contribution income statement (shown in Exhibit 16.1) presents information on total sales revenue, total variable costs, and so forth, it is sometimes useful to present information on a per-unit or portion of sales basis.

	Total	Per Unit	Ratio to Sales
Sales (5,400 units)	\$324,000	\$60	1.0000
Variable costs.....	(205,200)	38	0.6333*
Contribution margin.....	118,800	\$22	0.3667
Fixed costs	(50,000)		
Profit.....	\$ 68,800		

* Rounded

The per-unit information assists in short-range planning. The **unit contribution margin** is the difference between the unit selling price and the unit variable costs. It is the amount, \$22 in this case, that each unit contributes toward covering fixed costs and earning a profit.

The contribution margin is widely used in **sensitivity analysis** (the study of the responsiveness of a model to changes in one or more of its independent variables). Razor's income statement is an economic model of the firm, and the unit contribution margin indicates how sensitive Razor's income model is to changes in unit sales. If, for example, sales increase by 100 scooters per month, the increase in profit is readily determined by multiplying the 100-scooter increase in sales by the \$22 unit contribution margin as follows:

100 (scooter sales increase) × \$22 (unit contribution margin) = \$2,200 (profit increase)

There is no increase in fixed costs, so the new profit level becomes \$71,000 (\$68,800 + \$2,200) per month.

When expressed as a ratio to sales, the sales margin is identified as the **contribution margin ratio**. It is the portion of each dollar of sales revenue contributed toward covering fixed costs and earning a profit. In the abbreviated income statement above, the portion of each dollar of sales revenue contributed toward covering fixed costs and earning a profit is \$0.3667 ($\$118,800 \div \$324,000$). This is Razor's assumed contribution margin ratio. If sales revenue increases by \$6,000 per month, the increase in profits is computed as follows:

\$6,000 (sales increase) × 0.3667 (contribution margin ratio) = \$2,200 (profit increase)

The contribution margin ratio is especially useful in situations involving several products or when unit sales information is not available.

Review 16-2 LO2



Assume **Solo Cup Company** produces 16-ounce beverage containers. Further assume Solo sells the cups for \$40 per box of 50 containers. Variable and fixed costs follow:

Variable Costs per Box		Fixed Costs per Month	
Manufacturing		Manufacturing overhead.....	\$15,000
Direct materials.....	\$15	Selling and administrative	<u>10,000</u>
Direct labor.....	3	Total	<u><u>\$25,000</u></u>
Manufacturing overhead	<u>10</u>		
Selling and administrative	<u>2</u>		
Total	<u><u>\$30</u></u>		

Suppose in September 2017, Solo produced and sold 3,000 boxes of beverage containers.

Required

- a. Prepare a contribution income statement for September 2017.
- b. Determine Solo's unit contribution margin and contribution margin ratio.

Break-Even Point and Profit Planning



The **break-even point** occurs at the unit or dollar sales volume when total revenues equal total costs. The break-even point is of great interest to management. Until break-even sales are reached, the product, service, event, or business segment of interest operates at a loss. Beyond this point, increasing levels of profits are achieved. Also, management often wants to know the **margin of safety**, the amount by which actual or planned sales exceed the break-even point. Other questions of interest include the probability of exceeding the break-even sales volume and the effect of some proposed change on the break-even point.

Determining Break-Even Point in Units

In determining the break-even point, the equation for total revenues is set equal to the equation for total costs and then solved for the break-even unit sales volume. Using the general equations for total revenues and total costs, the following results are obtained. Setting total revenues equal to total costs:

$$\text{Total revenues} = \text{Total costs}$$

$$pX = a + bX$$

Solving for the break-even unit sales volume:

$$\begin{aligned} pX - bX &= a \\ (p - b)X &= a \\ X &= a/(p - b) \end{aligned}$$

In words:

$$\text{Break-even unit sales volume} = \frac{\text{Fixed costs}}{\text{Selling price per unit} - \text{Variable costs per unit}}$$

Because the denominator is the unit contribution margin, the break-even point is also computed by dividing fixed costs by the unit contribution margin:

$$\text{Break-even unit sales volume} = \frac{\text{Fixed costs}}{\text{Unit contribution margin}}$$

With an assumed \$22 unit contribution margin and fixed costs of \$50,000 per month, Razor's break-even point is 2,273* units per month ($\$50,000 \div \22). Stated another way, at a \$22 per-unit contribution margin, 2,273 units of sales are required to cover \$50,000 of fixed costs. With a break-even point of 2,273 units, the monthly margin of safety for a sales volume of 5,400 units is 3,127 units (5,400 expected unit sales – 2,273 break-even unit sales). The expected profit at a sales volume of 5,400 units is \$68,794 (3,127 unit margin of safety \times \$22 unit contribution margin). (The difference between the calculated \$68,794 and the profit of \$68,800 in Exhibit 16.1 and 3.2 is due to rounding.)

*Rounded UP to the nearest whole unit

The break-even point concept is applicable to a wide variety of business and personal planning situations. The following Research Insight box illustrates how a personal financial planner might use break-even point concepts to assist a client making a retirement decision.

Research Insight ■ Determining the Cash Break-Even Point for Delaying Retirement

Social Security retirement benefits are a function of years worked, contributions to the Social Security System, and the age at which the recipient files for Social Security retirement benefits. Currently, persons retiring at age 67 are entitled to "full" retirement benefits, while those retiring at age 62 are eligible for only 70 percent of "full" benefits. A person contemplating retirement at age 62 might ask: (1) how large is the reduction in benefits and (2) what is the break-even age at which the benefits from delaying retirement until age 67 equals the cumulative benefits from retiring at age 62?

An individual with the analytic skills obtained from a managerial accounting course can readily determine the answers to these questions after consulting the Social Security web site www.ssa.gov. Others might consult a personal financial planner.

- (1) Assume the individual's full Social Security retirement benefits at age 67 are \$2,265 per month. If that person started receiving benefits at age 62 their monthly benefits are reduced by 30 percent or \$679.50 ($\$2,265 \times 0.30$) to \$1,585.50.
- (2) With retirement at age 62, the early retiree would receive total benefits of \$95,130 ($\$1,585.50 \times 12 \text{ months} \times 5 \text{ years}$) by age 67, the normal "full" age. Treating this as a fixed amount to be recovered by the subsequent incremental monthly benefits of \$679.50 from delaying the receipt of monthly benefits to age 67, the break-even age is computed as follows:

$$\text{Months beyond age 67} = \$95,130 / \$679.50 = 140 \text{ months or } 11.67 \text{ years.}$$

Hence, the break-even age is 78.67 years (67 + 11.67).

The analysis suggests that life expectancy is an important consideration in deciding when to start taking Social Security benefits.

Note that this analysis does not consider any return on the \$95,130 that might be earned by investing the benefits received during early retirement. Such returns would increase the break-even age. Nor does it consider the lost wages that could have been earned between age 62 and age 67.

Source: www.ssa.gov

Profit Planning

Establishing profit objectives is an important part of planning in for-profit organizations. Profit objectives are stated in many ways. They can be set as a percentage of last year's profits, as a percentage of total assets at the start of the current year, or as a percentage of owners' equity. They might be based on a profit trend, or they might be expressed as a percentage of sales. The economic outlook for the firm's products as well as anticipated changes in products, costs, and technology are also considered in establishing profit objectives.

Before incorporating profit plans into a detailed budget, it is useful to obtain some preliminary information on the feasibility of those plans. Cost-volume-profit analysis is one way of doing this. By manipulating cost-volume-profit relationships, management can determine the sales volume corresponding to a desired profit. Management might then evaluate the feasibility of this sales volume. If the profit plans are feasible, a complete budget might be developed for this activity level. The required sales volume might be infeasible because of market conditions or because the required volume exceeds production or service capacity, in which case management must lower its profit objective or consider other ways of achieving it. Alternatively, the required sales volume might be less than management believes the firm is capable of selling, in which case management might raise its profit objective.

Assume that Razor's management desires to know the unit sales volume required to achieve a monthly profit of \$75,000. Using the profit formula, the required unit sales volume is determined by setting profits equal to \$75,000 and solving for X , the unit sales volume.

$$\text{Profit} = \text{Total revenues} - \text{Total costs}$$

$$\$75,000 = \$60X - (\$50,000 + \$38X)$$

Solving for X

$$\$60X - \$38X = \$50,000 + \$75,000$$

$$X = (\$50,000 + \$75,000) \div \$22$$

$$= 5,682 \text{ units (rounded UP to the nearest whole unit)}$$

The total contribution must cover the desired profit as well as the fixed costs. Hence, the target sales volume required to achieve a desired profit is computed as the fixed costs plus the desired profit, all divided by the unit contribution margin.

$$\text{Target unit sales volume} = \frac{\text{Fixed costs} + \text{Desired profit}}{\text{Unit contribution margin}}$$

The Business Insight box below considers CVP analysis for **Costco**, a large wholesale club whose strategic position for consumer goods focuses on cost leadership.

Business Insight ■ Cost, Volume, What Profit?

Costco customers are loyal. Its competitors have lost customers to Internet retailers, but Costco's sales have grown by nearly 40 percent over the past several years. Costco's customers are happy, its employees are happy, and its management is happy. The company's workers are paid on average \$20.89 per hour, which is nearly 65 percent higher than the average **Wal-Mart** worker. Nearly 90 percent of its employees have company-sponsored health insurance, whereas slightly over half of Wal-Mart workers do. Employees rarely leave the company—its turnover rate is only 5 percent.

But once Costco accounts for its real estate costs and wages for its employees, its merchandise barely breaks even. The company passes along its cost savings from buying its merchandise in bulk to the consumer, which ensures the company will have plenty of volume in its CVP analysis. But how has the company been in business for three decades without turning a profit on its merchandise? The company's profit is earned from its annual membership dues. Each member pays \$55 per year, but clearly Costco's customers believe this is a good bargain. Ninety percent of members renew their membership year over year. By selling their products to the customer at their break-even points, Costco will always make its necessary profit. Now that's a business model.

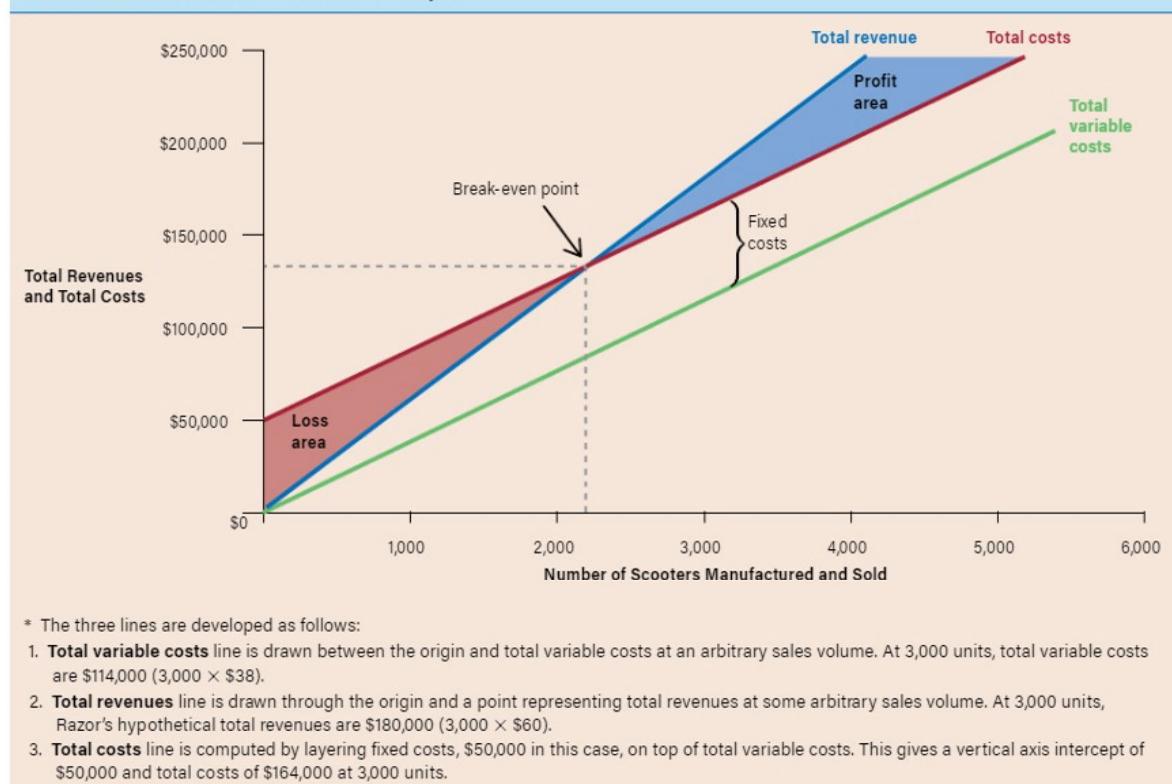
Source: Brad Stone, "Costco CEO Craig Jelinek Leads the Cheapest, Happiest Company in the World," *Bloomberg Businessweek*, June 6, 2013.

Cost-Volume-Profit Graph

A **cost-volume-profit graph** illustrates the relationships among activity volume, total revenues, total costs, and profits. Its usefulness comes from highlighting the break-even point and depicting revenue, cost, and profit relationships over a range of activity. This representation allows management to view the relative amount of important variables at any graphed volume. Razor's hypothetical monthly CVP graph is in Exhibit 16.3. Total revenues and total costs are measured on the vertical axis, with unit sales measured on the horizontal axis. Separate lines are drawn for total variable costs, total costs, and total revenues. The vertical distance between the total revenue and the total cost lines depicts the amount of profit or loss at a given volume. Losses occur when total revenues are less than total costs; profits occur when total revenues exceed total costs.

The total contribution margin is shown by the difference between the total revenue and the total variable cost lines. Observe that as unit sales increase, the contribution margin first goes to cover the fixed costs. Beyond the break-even point, any additional contribution margin provides a profit.

Exhibit 16.3 ■ Cost-Volume-Profit Graph*



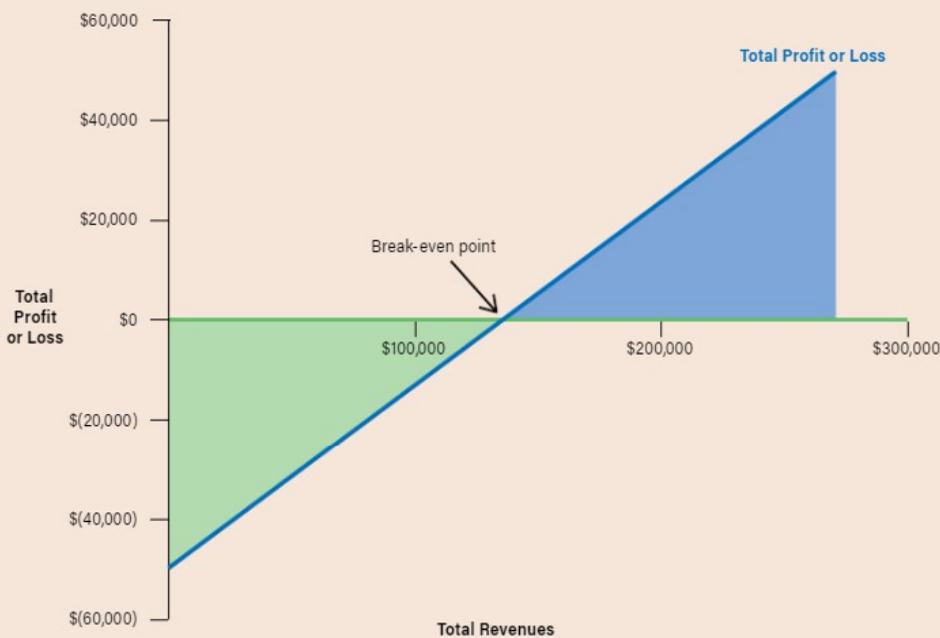
Profit-Volume Graph

In cost-volume-profit graphs, profits are represented by the difference between total revenues and total costs. When management is primarily interested in the impact of changes in sales volume on profits and less interested in the related revenues and costs, a **profit-volume graph** is sometimes used. A profit-volume graph illustrates the relationship between volume and profits; it does not show revenues and costs. Profits are read directly from a profit-volume graph, rather than being computed as the difference between total revenues and total costs. Profit-volume graphs are developed by plotting either unit sales or total revenues on the horizontal axis.

The Business Insight box on the following page discusses that GlaxoSmithKline expects a future reduction in its process costs. This would lead to a reduction in its required sales to breakeven.

Razor's assumed monthly profit-volume graph is presented in Exhibit 16.4. Profit or loss is measured on the vertical axis, and volume (total revenues) is measured on the horizontal axis, which

Exhibit 16.4 ■ Profit-Volume Graph*



* The profit line is drawn by determining and plotting profit or loss at two different volumes and then drawing a straight line through the plotted values. Perhaps the easiest values to select are the loss at a volume of zero (with a loss equal to the fixed costs) and the volume at which the profit line crosses the horizontal axis (this is the break-even volume).

intersects the vertical axis at zero profit. A single line, representing total profit, is drawn intersecting the vertical axis at zero sales volume with a loss equal to the fixed costs. The profit line crosses the horizontal axis at the break-even sales volume. The profit or loss at any volume is depicted by the vertical difference between the profit line and the horizontal axis. The slope of the profit line is determined by the contribution margin. The greater the contribution margin ratio or the unit contribution margin, the steeper the slope of the profit line.

Business Insight ■ Drugmaker Looks to Bioelectronics to Change Cost Structure

At **GlaxoSmithKline's** (GSK) bioelectronics unit, treatments are not pills or serums delivering doses of chemicals to the entire body but rice-sized devices attached to nerve bundles. The innovation here is treating illness as a programming problem rather than as a chemical problem. The nervous system can be viewed as a communication system carrying messages about the body's operations. To the extent that problematic messages can be edited, many health problems can be solved by implanting and programming these devices. In addition to finding new solutions to old pathologies, GSK hopes to eventually change the cost structure of drug companies. GSK has started a venture capital effort worth \$50 million that funds 100 independent researchers and 30 employees.

Development costs are exploding for conventional molecular drug therapies. The average drug takes 10 years and \$2.6 billion to bring to market. GSK is betting that basic engineering innovations in bioelectronics will allow new therapies to be tested and implemented more quickly and at lower cost. This could potentially change some therapies into software problems rather than manufacturing problems, eliminating many of the process costs involved in manufacturing drugs under the current model. These investments remain risky, but GSK is hoping that its investment in this technology changes the cost structure of the drug business.

Source: Matthew Campbell, "Only One Big Drugmaker Is Working on a Nanobot Cure," *Bloomberg Businessweek*, June 9, 2016.

Impact of Income Taxes

Income taxes are imposed on individuals and for-profit organizations by government agencies. The amount of an individual's or organization's income tax is determined by laws that specify the calculation of taxable income (the income subject to tax) and the calculation of the amount of tax on taxable income. Income taxes are computed as a percentage of taxable income, with increases in taxable income usually subject to progressively higher tax rates. The laws governing the computation of taxable income differ in many ways from the accounting principles that guide the computation of accounting income. Consequently, taxable income and accounting income are seldom the same.

In the early stages of profit planning, income taxes are sometimes incorporated in CVP models by assuming that taxable income and accounting income are identical and that the tax rate is constant. Although these assumptions are seldom true, they are useful for assisting management in developing an early prediction of the sales volume required to earn a desired after-tax profit. Once management has developed a general plan, this early prediction should be refined with the advice of tax experts.

Assuming taxes are imposed at a constant rate per dollar of before-tax profit, income taxes are computed as before-tax profit multiplied by the tax rate. After-tax profit is equal to before-tax profit minus income taxes.

$$\text{After-tax profit} = \text{Before-tax profit} - (\text{Before-tax profit} \times \text{Tax rate})$$

After-tax profit can also be expressed as before-tax profit times 1 minus the tax rate.

$$\text{After-tax profit} = \text{Before-tax profit} \times (1 - \text{Tax rate})$$

This formula can be rearranged to isolate before-tax profit as follows:

$$\text{Before-tax profit} = \frac{\text{After-tax profit}}{(1 - \text{Tax rate})}$$

Since all costs and revenues in the profit formula are expressed on a before-tax basis, the most straightforward way of determining the unit sales volume required to earn a desired after-tax profit is to:

1. Determine the required before-tax profit.
2. Substitute the required before-tax profit into the profit formula.
3. Solve for the required unit sales volume.

To illustrate, assume that Razor is subject to a 40 percent tax rate and that management desires to earn an after-tax profit of \$75,000 for November 2017. The required before-tax profit is \$125,000 [$\$75,000 \div (1 - 0.40)$], and the unit sales volume required to earn this profit is 7,955 units [$(\$50,000 + \$125,000) \div \$22$]. Rounded to the nearest whole unit.

Income taxes increase the sales volume required to earn a desired after-tax profit. A 40 percent tax rate increased the sales volume required for Razor to earn an after-tax profit of \$75,000 from 5,682 to 7,955 units. These amounts are verified in Exhibit 16.5.

Another way to remember the computation of before-tax profit is shown on the right side of Exhibit 16.5. The before-tax profit represents 100 percent of the pie, with 40 percent going to income taxes and 60 percent remaining after taxes. Working back from the remaining 60 percent (\$75,000), we can determine the 100 percent (before-tax profit) by dividing after-tax profit by 0.60.

Exhibit 16.5 ■ Contribution Income Statement with Income Taxes

RAZOR COMPANY Contribution Income Statement Planned for the Month of November 2017		
Sales ($7,955 \times \$60$)	\$477,300	
Less variable costs		
Direct materials ($7,955 \times \$20$)	\$159,100	
Direct labor ($7,955 \times \$10$)	79,550	
Manufacturing overhead ($7,955 \times \$3$)	23,865	
Selling and administrative ($7,955 \times \$5$)	39,775	(302,290)
Contribution margin.....		175,010
Less fixed costs		
Manufacturing overhead	35,000	
Selling and administrative	15,000	50,000
Before-tax profit		125,000*
Income taxes ($\$125,000 \times 0.40$)		(50,000)
After-tax profit		\$ 75,000
*Calculated total is \$125,010. Difference is due to rounding.		

Review 16-3 LO3


Assume **Solo Cup Company** produces 16-ounce beverage containers. Further assume Solo sells the cups for \$40 per box of 50 containers. Variable and fixed costs follow:

Variable Costs per Box		Fixed Costs per Month	
Manufacturing		Manufacturing overhead	\$15,000
Direct materials.....	\$15	Selling and administrative	10,000
Direct labor.....	3	Total	\$25,000
Manufacturing overhead	10		
Selling and administrative	2		
Total	\$30		

Suppose in September 2017, Solo produced and sold 3,000 boxes of beverage containers.

Required

- Prepare a cost-volume-profit graph with unit sales as the independent variable. Label the revenue line, total costs line, fixed costs line, loss area, profit area, and break-even point. The recommended scale for the horizontal axis is 0 to 5,000 units, and the recommended scale for the vertical axis is \$0 to \$200,000.
- Determine Solo's monthly break-even point in units.
- Determine the monthly dollar sales required for a monthly profit of \$5,000 (ignoring taxes).
- Assuming Solo is subject to a 40 percent income tax, determine the monthly unit sales required to produce a monthly after-tax profit of \$4,500.

Solution on p. 16-38.

Multiple-Product Cost-Volume-Profit Analysis



Analyze the profitability and sales mix of a multiple-product firm.

Determining Break-Even and Target Profit Sales Dollars

Unit cost information is not always available or appropriate when analyzing cost-volume-profit relationships of multiple-product firms. Assuming the sales mix is constant, the contribution margin ratio (the portion of each sales dollar contributed toward covering fixed costs and earning a profit) can be used to determine the break-even dollar sales volume or the dollar sales volume required to achieve a desired profit. Treating a dollar of sales revenue as a unit, the break-even point in dollars is computed

as fixed costs divided by the contribution margin ratio (the number of cents from each dollar of revenue contributed to covering fixed costs and providing a profit).

$$\text{Dollar break-even point} = \frac{\text{Fixed costs}}{\text{Contribution margin ratio}}$$

If unit selling price and cost information were not available, Razor's dollar break-even point could be computed as \$136,351 ($\$50,000 \div 0.3667$). Rounded to the nearest whole unit.

Corresponding computations can be made to find the dollar sales volume required to achieve a desired profit as follows.

$$\text{Target dollar sales volume} = \frac{\text{Fixed costs} + \text{Desired profit}}{\text{Contribution margin ratio}}$$

To achieve a desired profit of \$82,000, Razor needs sales of \$359,967 [$(\$50,000 + \$82,000) \div 0.3667$]. Rounded to the nearest whole unit.

These relationships can be graphed by placing sales dollars, rather than unit sales, on the horizontal axis. The slope of the variable and total cost lines, identified as the **variable cost ratio**, presents variable costs as a portion of sales revenue. It indicates the number of cents from each sales dollar required to pay variable costs. The Business Insight box below demonstrates how CVP information can be developed from the published financial statements of a multiple-product firm.

Business Insight ■ Using CVP for Financial Analysis and Prediction

Apple Inc. manufactures consumer electronics including the iPhone, Mac computers, and other devices. We can use historical data to predict future costs through the cost-volume-profit method. We used data from the condensed 2013 and 2014 income statements (in millions) to predict 2015 costs:

	For the Year Ending	
	September 31, 2014	September 31, 2013
Sales.....	\$182,795	\$170,910
Cost of sales and operating expenses	(130,292)	(121,911)
Operating profit.....	\$ 52,503	\$ 48,999

We can use the high-low method to understand Apple's cost-volume-profit relationships and forecast profits based on expected sales. The first step is to calculate variable costs as a percentage of sales:

$$\text{Variable cost ratio} = \frac{\$130,292 - \$121,911}{\$182,795 - \$170,910} = 0.7052$$

Next, use this ratio to estimate Apple's fixed costs by subtracting variable costs from total costs for either period. Based on 2014 revenues and variable costs, we can calculate fixed costs as:

$$\text{Annual fixed costs} = \$130,292 - (\$182,795 \times 0.7052) = \$1,385 \text{ million}$$

Our estimate of Apple's cost function is:

$$\text{Total annual costs} = \$1,385 \text{ million} + (0.7052 \times \text{Sales})$$

Apple's break-even sales can be calculated using fixed cost and contribution margin (1 minus the variable cost ratio).

$$\text{Break-even point} = \$1,385 \text{ million}/(1 - 0.7052) = \$4,698 \text{ million}$$

In 2015 sales were \$233,715 million and operating income was \$71,230 million. Based on the CVP relationships developed above and 2015 sales, the predicted level of operating income is:

$$\text{Predicted operating income} = \$233,715 - [(\$233,715 \times 0.7052) + \$1,385] = \$67,514$$

The error in this estimate suggests that Apple's cost structure has changed somewhat over the past three years.

Sales Mix Analysis

Sales mix refers to the relative portion of unit or dollar sales that are derived from each product. One of the limiting assumptions of the basic cost-volume-profit model is that the analysis is for a single product or the sales mix is constant. When the sales mix is constant, managers of multiple-product organizations can use the average unit contribution margin, or the average contribution margin ratio, to determine the break-even point or the sales volume required for a desired profit. Often, however, management is interested in the effect of a change in the sales mix rather than a change in the sales volume at a constant mix. In this situation, it is necessary to determine either the average unit contribution margin or the average contribution margin ratio for each alternative mix.

Unit Sales Analysis

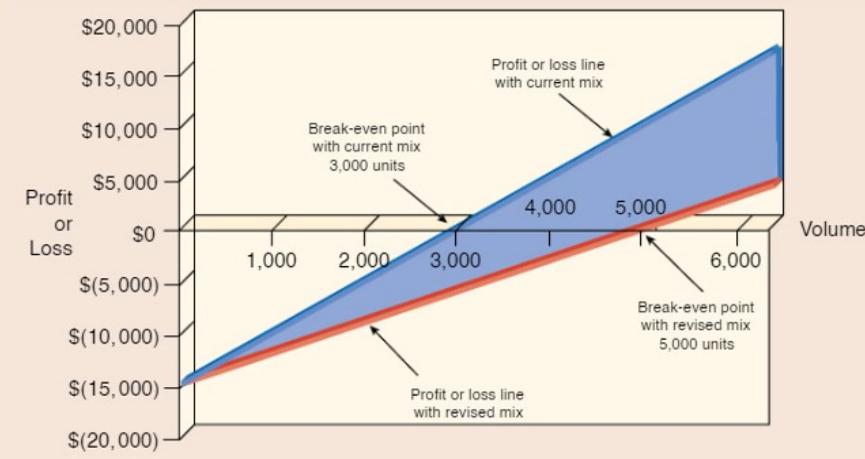
Assume the **Hallmark Cards** sells two kinds of greeting cards, regular and deluxe. At a 1:1 (one-to-one) unit sales mix in which Hallmark sells one box of regular cards for every box of deluxe cards, assume the following revenue and cost information is available:

	Regular Box	Deluxe Box	Average Box*
Unit selling price.....	\$4	\$12	\$8
Unit variable costs.....	(3)	(3)	(3)
Unit contribution margin.....	\$1	\$ 9	\$5
Fixed costs per month.....			<u><u>\$15,000</u></u>

* At a 1:1 sales mix, the average unit contribution margin is $\$5[(\$1 \times 1 \text{ unit}) + (\$9 \times 1 \text{ unit})] \div 2 \text{ units}$.

At a 1:1 mix, Hallmark's assumed monthly break-even sales volume is 3,000 units ($\$15,000 \div \5), consisting of 1,500 boxes of regular cards and 1,500 boxes of deluxe cards. The top line in Exhibit 16.6 represents the current sales mix. Suppose management wants to know the break-even sales volume if the unit sales mix became 3:1; that is, on average, a sale of 4 units contains 3 regular units and 1 deluxe unit. With no changes in the selling prices or variable costs of individual products, the average contribution margin becomes $\$3[(\$1 \times 3 \text{ units}) + (\$9 \times 1 \text{ unit})] \div 4 \text{ units}$, and the revised break-even sales volume is 5,000 units ($\$15,000 \div \3). The revised break-even sales volume includes 3,750 boxes of regular cards [$5,000 \times \frac{3}{4}$] and 1,250 boxes of deluxe cards [$5,000 \times \frac{1}{4}$].

Exhibit 16.6 ■ Sales Mix Analysis: Unit Sales Approach



The bottom line in Exhibit 16.6 represents the revised sales mix. Because a greater portion of the revised mix consists of lower contribution margin regular cards, the shift in the mix increases the break-even point.

Sales Dollar Analysis

The preceding analysis focused on units and the unit contribution margin. An alternative approach focuses on sales dollars and the contribution margin ratio. Following this approach, the sales mix is expressed in terms of sales dollars.

Assume Hallmark's current sales dollars are 25 percent from regular cards and 75 percent from deluxe cards. The following display indicates the contribution margin ratios at the current sales mix and monthly volume of 5,400 units.

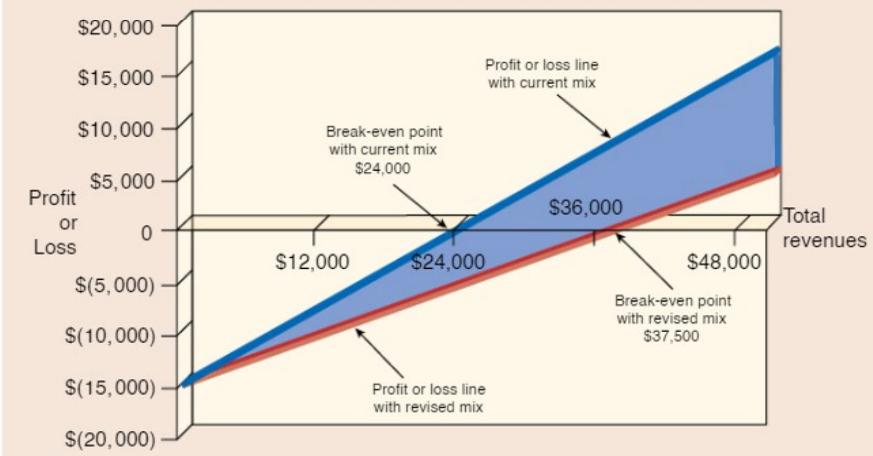
	Regular	Deluxe	Total
Unit sales.....	2,700	2,700	
Selling price.....	\$4.00	\$12.00	
Sales.....	\$10,800	\$32,400	\$43,200
Variable costs.....	8,100	8,100	16,200
Contribution margin.....	\$ 2,700	\$24,300	\$27,000
Contribution margin ratio.....	0.25	0.75	0.625

If monthly fixed costs are \$15,000, Hallmark's current break-even sales revenue is \$24,000 ($\$15,000 \div 0.625$), consisting of \$6,000 from regular cards ($\$24,000 \times 0.25$) and \$18,000 from deluxe cards ($\$24,000 \times 0.75$). The top line in Exhibit 16.7 illustrates the current sales mix.

Now suppose management wants to know the break-even sales volume if the dollar sales mix became 70 percent regular and 30 percent deluxe. With no changes in the selling prices or variable costs of individual products, the total contribution margin ratio becomes 0.40 [$(0.25 \times 0.70) + (0.75 \times 0.30)$], and the revised break-even sales volume is \$37,500 ($\$15,000 \div 0.40$). The revised break-even sales volume includes \$26,250 from regular cards ($\$37,500 \times 0.70$) and \$11,250 from deluxe cards ($\$37,500 \times 0.30$).

The bottom line in Exhibit 16.7 represents the revised sales mix. Because a greater portion of the revised mix consists of lower contribution ratio regular cards, the shift in the mix increases the break-even point.

Exhibit 16.7 ■ Sales Mix Analysis: Sales Dollar Approach



Sales mix analysis is important in multiple-product or service organizations. Management is just as concerned with the mix of products as with the total unit or dollar sales volume. A shift in the sales mix can have a significant impact on the bottom line. Profits may decline, even when sales increase, if the mix shifts toward products or services with lower unit margins. Conversely, profits may increase, even when sales decline, if the mix shifts toward products or services with higher unit margins. Other things being equal, managers of for-profit organizations strive to increase sales of high-margin products or services.



Suppose the Coffee Bean has a new shop in a Cambridge village shopping center that sells high-end teas and coffees. Further, suppose it has added smoothie drinks to its product line. Below are the assumed sales and cost data for the company:

	Coffee	Tea	Smoothie
Sales price per (12 oz.) serving.....	\$1.35	\$1.25	\$1.95
Variable cost per serving	0.60	0.45	0.75
Fixed costs per month \$8,000			

Suppose the company sells each month an average of 6,000 servings of coffee, 3,750 servings of tea, and 2,250 servings of smoothies.

Required

- Calculate the current before-tax profit, contribution margin ratio, and sales mix based on sales dollars.
- Using a sales dollar analysis, calculate the monthly break-even point assuming the sales mix does not change.

Solution on p. 16-39.

Analysis of Operating Leverage



Operating leverage refers to the extent that an organization's costs are fixed. The **operating leverage ratio** is computed as the contribution margin divided by before-tax profit as follows.

$$\text{Operating leverage ratio} = \frac{\text{Contribution margin}}{\text{Before-tax profits}}$$

The rationale underlying this computation is that as fixed costs are substituted for variable costs, the contribution margin as a percentage of income before taxes increases. Hence, a high degree of operating leverage signals the existence of a high portion of fixed costs. As noted in Module 14, the shift from labor-based to automated activities has resulted in a decrease in variable costs and an increase in fixed costs, producing an increase in operating leverage.

Operating leverage is a measure of risk and opportunity. Other things being equal, the higher the degree of operating leverage, the greater the opportunity for profit with increases in sales. Conversely, a higher degree of operating leverage also magnifies the risk of large losses with a decrease in sales.

	Operating Leverage	
	High	Low
Profit opportunity with sales increase	High	Low
Risk of loss with sales decrease.....	High	Low

In addition to indicating the relative amount of fixed costs in the overall cost structure of a company, the operating leverage ratio can be used to measure the expected change in net income resulting from a change in sales. The operating leverage ratio multiplied times the percentage change in sales equals the percentage change in income before taxes. For example, if **Razor** currently has an operating leverage ratio of 1.73, a change in sales of 12 percent will result in a 21 percent change in before-tax profit; whereas, suppose **Envy** has an operating leverage ratio of 2.35, which will result in an increase in before-tax profit of 28%.

	Current		Projected	
	Razor	Envy	Razor	Envy
Unit selling price.....	\$ 60	\$ 60	\$ 60	\$ 60
Unit variable costs.....	(38)	(30)	(38)	(30)
Unit contribution margin.....	\$ 22	\$ 30	\$ 22	\$ 30
Unit sales.....	× 5,400	× 5,400	× 6,048	× 6,048
Contribution margin.....	\$118,800	\$162,000	\$133,056	\$181,440
Fixed costs.....	(50,000)	(93,200)	(50,000)	(93,200)
Before-tax profit.....	\$ 68,800	\$ 68,800	\$ 83,056	\$ 88,240
Contribution margin.....	\$118,800	\$162,000		
Before-tax profit.....	+ 68,800	+ 68,800		
Operating leverage ratio.....	1.73*	2.35*		
Percent increase in sales.....			12%	12%
Percent increase in income before taxes.....			21%*	28%*

* Rounded

Although both companies have identical before-tax profits at a sales volume of 5,400 units, assume Envy has a higher degree of operating leverage and its profits vary more with changes in sales volume.

If sales are projected to increase by 12 percent, from 5,400 to 6,048 units, the percentage of increase in each firm's profits is computed as the percent change in sales multiplied by the degree of operating leverage.

	Razor	Envy
Increase in sales.....	12%	12%
Degree of operating leverage.....	× 1.73	× 2.35
Increase in profits.....	21%*	28%*

* Rounded

As noted in the following Business Insight box, operating leverage is an important consideration when changes in demand, and consequently sales, occur.

Management is interested in measures of operating leverage to determine how sensitive profits are to changes in sales. Risk-averse managers strive to maintain a lower operating leverage, even if this results in some loss of profits. One way to reduce operating leverage is to use more direct labor and less automated equipment. Another way is to contract outside organizations to perform tasks that could be done internally. While operating leverage is a useful analytic tool, long-run success comes from keeping the overall level of costs down, while providing customers with the products or services they want at competitive prices.

Business Insight ■ Mining Companies Fight for Financial Flexibility When Prices Fall

While larger mining companies like **BHP Billiton** and **Rio Tinto** have the flexibility to maintain output when ore prices fall, smaller miners like the **Australian Fortescue Metals Group** struggle to deal with low prices. Cost cutting can only help so much when debt is nearly four times earnings. This makes Fortescue's profit exceptionally sensitive to sale price and volume; hence, China's slowdown in economic growth has corresponded to a 90% drop in profit for the company. As a result, Fortescue and other mid-sized mining firms are rushing to restructure their debt.

In response to the same pressures, other mining companies, like **AngloAmerican**, are selling assets to reduce operational leverage. In contrast, **South32**, a recent BHP Billiton spin-off, is less sensitive to demand fluctuations because its net debt is less than a quarter of pretax earnings. South32's more nimble financial structure makes it much easier for the company to deal with fluctuations in price and demand. Financial flexibility is an important consideration in industries such as mining, where fixed costs are high and demand is sensitive to macroeconomic fluctuations.

Source: "Miners: In Search of Flexibility," *Financial Times*, August 25, 2015, London edition, 14.

As manager of a division responsible for both production and sales of products and, hence, division profits, you are looking for ways to leverage the profits of your division to a higher level. You are considering changing your cost structure to include more fixed costs and less variable costs by automating some of the production activities currently performed by people. What are some of the considerations that you should keep in mind as you ponder this decision? [Answer, p. 16-24]

Review 16-5 LO5



Suppose the Coffee Bean has a new shop in a Cambridge village shopping center that sells high-end teas and coffees. Further, suppose it has added smoothie drinks to its product line. Below are the assumed sales and cost data for the company:

	Coffee	Tea	Smoothie
Sales price per (12 oz.) serving.....	\$1.35	\$1.25	\$1.95
Variable cost per serving	0.60	0.45	0.75
Fixed costs per month \$8,000			

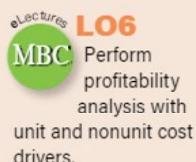
Suppose the company sells each month an average of 6,000 servings of coffee, 3,750 servings of tea, and 2,250 servings of smoothies.

Required

Calculate Coffee Bean's operating leverage ratio. If sales increase by 20 percent, by how much will before-tax income be expected to change? If sales decrease by 20 percent, by how much will before-tax income be

Solution on p. 16-39. expected to change?

Appendix 16A: Profitability Analysis with Unit and Nonunit Cost Drivers



A major limitation of cost-volume-profit analysis and the related contribution income statement is the exclusive use of unit-level activity cost drivers. Even when multiple products are considered, the CVP approach either restates volume in terms of an average unit or in terms of a dollar of sales volume. Additionally, CVP analysis does not consider other categories of cost drivers.

We now expand profitability analysis to incorporate nonunit cost drivers. While the addition of multiple levels of cost drivers makes it difficult to develop graphical relationships (illustrating the impact of cost driver changes on revenues, costs, and profits), it is possible to modify the traditional contribution income statement to incorporate a hierarchy of cost drivers. The expanded framework is not only more accurate, but it encourages management to ask important questions concerning costs and profitability.

Multi-Level Contribution Income Statement

To illustrate the use of profitability analysis with unit and nonunit cost drivers, assume **Anthropologie**, a multiple-product merchandising organization, has the following cost hierarchy:

Unit-level activities	
Cost of goods sold	\$0.80 per sales dollar
Order-level activities	
Cost of processing order	\$20 per order
Customer-level activities	
Mail, phone, sales visits, recordkeeping, etc.....	\$200 per customer per year
Facility-level costs	
Depreciation, manager salaries, insurance, etc.....	\$120,000 per year

Assume that Anthropologie is subject to a 40 percent income tax rate and has the following plans for the year 2017:

Sales.....	\$3,000,000
Number of sales orders.....	3,200
Number of customers	400

While Anthropologie's plans could be summarized in a functional income statement, we have previously considered the limitations of such statements for management. Contribution income statements are preferred because they correspond to the cost classification scheme used in CVP analysis. In this case, Anthropologie's cost structure (unit level, order level, customer level, and facility level) does not correspond to the classification scheme used in traditional contribution income statements (variable and fixed). The problem occurs because traditional contribution income statements consider only unit-level cost drivers. When a larger set of unit and nonunit cost drivers is used for cost analysis, an expanded contribution income statement should be used for profitability analysis.

A hypothetical multi-level contribution income statement for Anthropologie is presented in Exhibit 16A.1. Costs are separated using a cost hierarchy and there are several contribution margins, one for each level of costs that responds to a short-run change in activity. Suppose that in the case of Anthropologie, the contribution margins are at the unit level, order level, and customer level. Because the facility-level costs do not vary with short-run variations in activity, the final customer-level contribution goes to cover facility-level costs and to provide for a profit. If a company had a different activity cost hierarchy, it would use a different set of contribution margins.

Exhibit 16A.1 ■ Multi-Level Contribution Income Statement with Taxes

ANTHROPOLOGIE Multi-Level Contribution Income Statement For Year 2017	
Sales.....	\$3,000,000
Less unit-level costs	
Cost of goods sold ($\$3,000,000 \times 0.80$).....	<u>(2,400,000)</u>
Unit-level contribution margin	600,000
Less order-level costs	
Cost of processing order (3,200 orders $\times \$20$).....	<u>(64,000)</u>
Order-level contribution margin.....	536,000
Less customer-level costs	
Mail, phone, sales visits, recordkeeping, etc. (400 customers $\times \$200$).....	<u>(80,000)</u>
Customer-level contribution margin.....	456,000
Less facility-level costs	
Depreciation, manager salaries, insurance, etc.	<u>(120,000)</u>
Before-tax profit	336,000
Income taxes ($\$336,000 \times 0.40$).....	<u>(134,400)</u>
After-tax profit	<u>\$ 201,600</u>

A number of additional questions of interest to management can be formulated and answered using the multi-level hierarchy. Consider the following examples:

- Holding the number of sales orders and customers constant, what is the break-even dollar sales volume? The answer is found by treating all other costs as fixed and dividing the total nonunit-level costs by the contribution margin ratio. Here the contribution margin ratio indicates how many cents of each sales dollar is available for profits and costs above the unit level.

Unit-Level Break-Even Point In Dollars With No Changes In Other Costs	Current Order-Level Costs			Current Customer- Level Costs		Facility- Level Costs				
				Contribution Margin Ratio						
	$= (\$64,000 + \$80,000 + \$120,000) \div (1 - 0.80)$									
	$= \$1,320,000$									

- What order size is required to break even on an individual order? Answering this question might help management to evaluate the desirability of establishing a minimum order size. To break even, each order must have a unit-level contribution equal to the order-level costs. Any additional contribution is used to cover customer- and facility-level costs and provide for a profit.

$$\begin{aligned}\text{Break-even order size} &= \$20 \div (1 - 0.80) \\ &= \$100\end{aligned}$$

- What sales volume is required to break even on an average customer? Answering this question might help management to evaluate the desirability of retaining certain customers. Based on the preceding information, an average customer places 8 orders per year ($3,200 \text{ orders} \div 400 \text{ customers}$). With costs of \$20 per order and \$200 per customer, the sales to an average customer must generate an annual contribution of $\$360 [(\$20 \times 8) + \$200]$. Hence, the break-even level for an average customer is $\$1,800 [\$360 \div (1 - 0.80)]$. Management might consider discontinuing relations with customers with annual purchases of less than this amount. Alternatively, they might inquire as to whether such customers could be served in a less costly manner.

The concepts of multi-level break-even analysis and profitability analysis are finding increasing use as companies such as FedEx, Best Buy, and Bank of America strive to identify profitable and unprofitable customers. At FedEx, customers are sometimes rated as “the good, the bad, and the ugly.” FedEx strives to retain the “good” profitable customers, turn the “bad” into profitable customers, and ignore the “ugly” who seem unlikely to become profitable.

Variations in Multi-Level Contribution Income Statement

Classification schemes should be designed to fit the organization and user needs. In Module 15, when analyzing the costs of a manufacturing company, we used a manufacturing cost hierarchy. While formatting issues can seem mundane and routine, format is important because the way information is presented encourages certain types of questions while discouraging others. Hence, management accountants must inquire as to user needs before developing management accounting reports, just as users of management accounting information should be knowledgeable enough to request appropriate information and know whether the information they are receiving is the information they need. With computers to reduce computational drudgery and to provide a wealth of available data, the most important issues involve identifying the important questions and presenting information to address those questions.

In the case of Anthropologie, we used a customer cost hierarchy with information presented in a single column. A multiple-column format is also useful for presenting and analyzing information. Assume that Anthropologie's management believes that the differences between the in-store and internet-based markets are such that these markets could be better served with separate marketing activities. They would have two market segments, one for the in-store customers and one for internet-based customers, giving the following cost hierarchy:

1. Unit-level activities
2. Order-level activities
3. Customer-level activities
4. Market segment activities
5. Facility-level activities

One possible way of presenting Anthropologie's 2017 hypothetical multi-level income statement with two market segments is shown in Exhibit 16A.2. The details underlying the development of this statement are not presented. In developing the statement, we assume the mix of units sold, their cost structure, and the costs of processing an order are unchanged. Finally, we present new market segment costs and assume that the addition of the segments allows for some reduction in previous facility-level costs.

The information in the total column is all that is required for a multi-level contribution income statement. The information in the two detailed columns for the government and private segments can, however, prove useful in analyzing the profitability of each. Observe that the facility-level costs, incurred for the benefit of both segments, are not assigned to specific segments. Depending on the nature of the goods sold, it may be possible to further analyze the profitability of each product (or type of product) sold in each market segment. The profitability analysis of business segments is more closely examined in Module 24.

Exhibit 16A.2 ■ Multi-Level Contribution Income Statement with Segments and Taxes

	ANTHROPOLOGIE Multi-Level Contribution Income Statement For Year 2017	In-Store Segment	Internet Segment	Total
Sales.....	\$1,500,000	\$2,000,000	\$3,500,000	
Less unit-level costs				
Cost of goods sold (0.80).....	(1,200,000)	(1,600,000)	(2,800,000)	
Unit-level contribution margin	300,000	400,000	700,000	
Less order-level costs				
Cost of processing order				
$(1,000 \times \$20; 3,000 \times \$20)$	(20,000)	(60,000)	(80,000)	
Order-level contribution margin.....	280,000	340,000	620,000	
Less customer-level costs				
Mail, phone, sales visits, recordkeeping, etc.				
$(150 \times \$200, 300 \times \$200)$	(30,000)	(60,000)	(90,000)	
Customer-level contribution margin.....	250,000	280,000	530,000	
Less market segment-level costs	(80,000)	(20,000)	(100,000)	
Market segment-level contribution	<u>\$ 170,000</u>	<u>\$ 260,000</u>	430,000	
Less facility-level costs				
Depreciation, manager salaries, insurance, etc.			(90,000)	
Before-tax profit			340,000	
Income taxes ($\$340,000 \times 0.40$).....			(136,000)	
After-tax profit			<u>\$ 204,000</u>	

LO6 Review 16-6

7-Eleven operates a number of convenience stores worldwide. Assume that an analysis of operating costs, customer sales, and customer patronage reveals the following:



Fixed costs per store	\$80,000/year
Variable cost ratio.....	0.80
Average sale per customer visit	\$17.00
Average customer visits per week.....	1.50
Customers as portion of city population	0.05

Required

Determine the city population required for a single 7-Eleven to earn an annual profit of \$40,000.

Solution on p. 16-39.

Guidance Answers
You are the Division Manager

Pg. 16-21 Fixed costs represent a two-edged sword. When a company is growing its sales, fixed costs cause profits to grow faster than sales; however, if a company should experience declining sales, the rate of reduction in profits is greater than the rate of reduction in sales. When sales decline, variable costs decline proportionately, while fixed costs continue. For this reason, when a company faces serious declines that are expected to continue, one of the first steps its top management should consider is reducing capacity in order to reduce fixed costs. The automobile companies in the U.S. have been employing this technique in recent years to try to offset the effect of sales lost to importers.

- Q16-1.** What is cost-volume-profit analysis and when is it particularly useful?
- Q16-2.** Identify the important assumptions that underlie cost-volume-profit analysis.
- Q16-3.** When is it most reasonable to use a single independent variable in cost-volume-profit analysis?
- Q16-4.** Distinguish between a contribution and a functional income statement.
- Q16-5.** What is the unit contribution margin? How is it used in computing the unit break-even point?
- Q16-6.** What is the contribution margin ratio and when is it most useful?
- Q16-7.** How is the break-even equation modified to take into account the sales required to earn a desired profit?
- Q16-8.** How does a profit-volume graph differ from a cost-volume-profit graph? When is a profit-volume graph most likely to be used?
- Q16-9.** What impact do income taxes have on the sales volume required to earn a desired after-tax profit?
- Q16-10.** How are profit opportunities and the risk of losses affected by operating leverage?

Assignments with the  logo in the margin are available in **BusinessCourse**.
See the Preface of the book for details.

Mini Exercises

LO3 M16-11. Profitability Analysis

Assume Strands, a local hair salon, provides cuts, perms, and hairstyling services. Annual fixed costs are \$150,000, and variable costs are 40 percent of sales revenue. Last year's revenues totaled \$300,000.

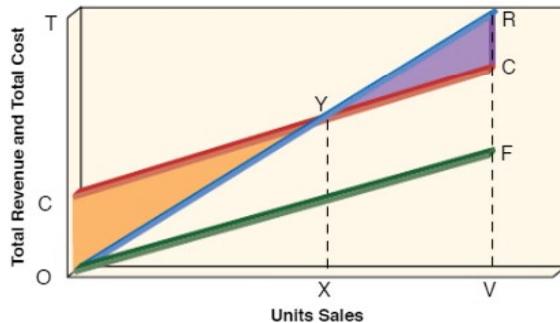


Required

- a. Determine its break-even point in sales dollars.
- b. Determine last year's margin of safety in sales dollars.
- c. Determine the sales dollar required for an annual profit of \$80,000.

LO3 M16-12. Cost-Volume-Profit Graph: Identification and Sensitivity Analysis

A typical cost-volume-profit graph is presented below.



Required

- a. Identify each of the following:
 1. Line OF
 2. Line OR
 3. Line CC
 4. The difference between lines OF and OV at any given number of unit sales
 5. The difference between lines CC and OF at any given number of unit sales
 6. The difference between lines CC and OV at any given number of unit sales
 7. The difference between lines OR and OF at any given number of unit sales
 8. Point X
 9. Area CYO
 10. Area RCY

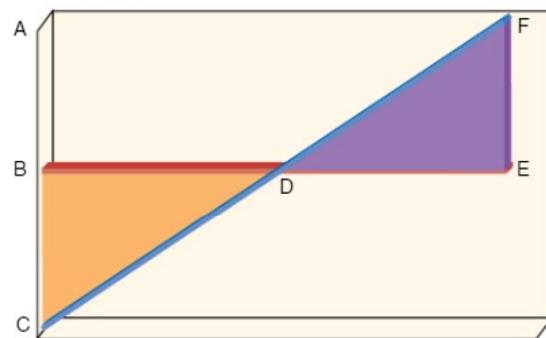
b. Indicate the effect of each of the following independent events on lines CC, OR, and the break-even point:

1. A decrease in fixed costs
2. An increase in unit selling price
3. An increase in the variable costs per unit
4. An increase in fixed costs and a decrease in the unit selling price
5. A decrease in fixed costs and a decrease in the unit variable costs

M16-13. Profit-Volume Graph: Identification and Sensitivity Analysis

LO3

A typical profit-volume graph follows.



Required

a. Identify each of the following:

1. Area BDC
2. Area DEF
3. Point D
4. Line AC
5. Line BC
6. Line EF

b. Indicate the effect of each of the following on line CF and the break-even point:

1. An increase in the unit selling price
2. An increase in the variable costs per unit
3. A decrease in fixed costs
4. An increase in fixed costs and a decrease in the unit selling price
5. A decrease in fixed costs and an increase in the variable costs per unit

M16-14. Preparing Cost-Volume-Profit and Profit-Volume Graphs

LO3

Assume a **Connie's Pizza** shop has the following monthly revenue and cost functions:

Connie's Pizza

$$\begin{aligned} \text{Total revenues} &= \$10.00X \\ \text{Total costs} &= \$17,000 + \$4.00X \end{aligned}$$

Required

- a. Prepare a graph (similar to that in Exhibit 16.3) illustrating Connie's cost-volume-profit relationships. The vertical axis should range from \$0 to \$72,000, in increments of \$12,000. The horizontal axis should range from 0 units to 6,000 units, in increments of 2,000 units.
- b. Prepare a graph (similar to that in Exhibit 16.4) illustrating Connie's profit-volume relationships. The horizontal axis should range from 0 units to 6,000 units, in increments of 2,000 units.
- c. When is it most appropriate to use a profit-volume graph?

LO3 M16-15. Preparing Cost-Volume-Profit and Profit-Volume Graphs

Tacos Locos is a taco concession business operating at five soccer parks. It sells large carnitas tacos for \$6.00 each. Variable costs are \$4.50 per taco, and fixed operating costs are \$750,000 per year.

Required

- Determine the annual break-even point in tacos.
- Prepare a cost-volume-profit graph for the company. Use a format that emphasizes the contribution margin. The vertical axis should vary between \$0 and \$5,000,000 in increments of \$1,000,000. The horizontal axis should vary between 0 tacos and 1,000,000 tacos, in increments of 250,000 tacos. Label the graph in thousands.
- Prepare a profit-volume graph for the company. The vertical axis should vary between \$(750,000) and \$750,000 in increments of \$150,000. The horizontal axis should vary as described in requirement (b). Label the graph in thousands.
- Evaluate the profit-volume graph. In what ways is it superior and in what ways is it inferior to the traditional cost-volume-profit graph?

LO4

Reebok

Bauer

Titan

**M16-16. Multiple Product Break-Even Analysis**

Slapshot company sells three styles of youth hockey sticks: **Reebok**, **Bauer** and **Titan**. Presented is information for Slapshot's three products.

	Reebok	Bauer	Titan
Unit selling price.....	\$150	\$200	\$80
Unit variable costs	115	132	40
Unit contribution margin.....	\$ 35	\$ 68	\$40

With monthly fixed costs of \$250,000, the company sells two Reebok sticks for each Bauer, and three Bauer for each Titan.

Required

Determine the number of Reebok sticks sold at the monthly break-even point.

Exercises

LO2, 3 E16-17. Contribution Income Statement and Cost-Volume-Profit Graph

Kopi Company produces dog cages that are sold for \$40 per unit. The company produced and sold 6,000 dog cages during July 2017. There were no beginning or ending inventories. Variable and fixed costs follow.

	Variable Costs per Unit	Fixed Costs per Month
Manufacturing:		
Direct materials.....	\$10	Manufacturing overhead..... \$40,000
Direct labor.....	2	Selling and administrative 20,000
Manufacturing overhead	5	Total \$60,000
Selling and administrative	5	
Total	\$22	

Required

- Prepare a contribution income statement for July.
- Prepare a cost-volume-profit graph. Label the horizontal axis in units with a maximum value of 10,000. Label the vertical axis in dollars with a maximum value of \$400,000. Draw a vertical line on the graph for the current (6,000) unit sales level, and label total variable costs, total fixed costs, and total profits at 6,000 units.



E16-18. Contribution Margin Concepts**LO3, 4**

The following information is taken from the 2017 records of Hendrix's Guitar Center.

	Fixed	Variable	Total
Sales.....			\$750,000
Costs			
Goods sold		\$337,500	
Labor	\$160,000	60,000	
Supplies.....	2,000	5,000	
Utilities.....	12,000	13,000	
Rent	24,000	—	
Advertising.....	6,000	24,500	
Miscellaneous.....	6,000	10,000	
Total costs.....	\$210,000	\$450,000	(660,000)
Net income.....			\$ 90,000

**Required**

- Determine the annual break-even dollar sales volume.
- Determine the current margin of safety in dollars.
- Prepare a cost-volume-profit graph for the guitar shop. Label both axes in dollars with maximum values of \$1,000,000. Draw a vertical line on the graph for the current (\$750,000) sales level, and label total variable costs, total fixed costs, and total profits at \$750,000 sales.
- What is the annual break-even dollar sales volume if management makes a decision that increases fixed costs by \$35,000?

E16-19. Multiple Product Planning with Taxes**LO3, 4**

In the year 2017, Pyramid Consulting had the following contribution income statement:

PYRAMID CONSULTING Contribution Income Statement For the Year 2017		
Sales revenue.....		\$1,300,000
Variable costs		
Cost of services.....	\$420,000	
Selling and administrative.....	200,000	(620,000)
Contribution margin.....		680,000
Fixed costs—selling and administrative		(285,000)
Before-tax profit		395,000
Income taxes (36%).....		(142,200)
After-tax profit		\$ 252,800

**Required**

- Determine the annual break-even point in sales revenue.
- Determine the annual margin of safety in sales revenue.
- What is the break-even point in sales revenue if management makes a decision that increases fixed costs by \$57,000?
- With the current cost structure, including fixed costs of \$285,000, what dollar sales revenue is required to provide an after-tax net income of \$200,000?
- Prepare an abbreviated contribution income statement to verify that the solution to requirement (d) will provide the desired after-tax income.

LO3 E16-20. Not-for-Profit Applications

Determine the solution to each of the following independent cases:

- a. Collings College has annual fixed operating costs of \$12,500,000 and variable operating costs of \$1,000 per student. Tuition is \$8,000 per student for the coming academic year, with a projected enrollment of 1,500 students. Expected revenues from endowments and federal and state grants total \$250,000. Determine the amount the college must obtain from other sources.
- b. The Collings College Student Association is planning a fall concert. Expected costs (renting a hall, hiring a band, etc.) are \$30,000. Assuming 3,000 people attend the concert, determine the break-even price per ticket. How much will the association lose if this price is charged and only 2,700 tickets are sold?
- c. City Hospital has a contract with the city to provide indigent health care on an outpatient basis for \$25 per visit. The patient will pay \$5 of this amount, with the city paying the balance (\$20). Determine the amount the city will pay if the hospital has 10,000 patient visits.
- d. A civic organization is engaged in a fund-raising program. On Civic Sunday, it will sell newspapers at \$1.25 each. The organization will pay \$0.75 for each newspaper. Costs of the necessary permits, signs, and so forth are \$500. Determine the amount the organization will raise if it sells 5,000 newspapers.
- e. Christmas for the Needy is a civic organization that provides Christmas presents to disadvantaged children. The annual costs of this activity are \$5,000, plus \$10 per present. Determine the number of presents the organization can provide with \$20,000.

LO3, 5

**Sanford LP
(SAN)**

**E16-21. Alternative Production Procedures and Operating Leverage**

Assume Sharpie, a brand of **Sanford LP**, is planning to introduce a new executive pen that can be manufactured using either a capital-intensive method or a labor-intensive method. The predicted manufacturing costs for each method are as follows:

	Capital Intensive	Labor Intensive
Direct materials per unit.....	\$ 5.00	\$ 6.00
Direct labor per unit.....	\$ 5.00	\$10.00
Variable manufacturing overhead per unit	\$ 4.00	\$ 2.00
Fixed manufacturing overhead per year	\$2,440,000	\$700,000

Sharpie's market research department has recommended an introductory unit sales price of \$40. The incremental selling costs are predicted to be \$500,000 per year, plus \$2 per unit sold.

Required

- a. Determine the annual break-even point in units if Sharpie uses the:
 1. Capital-intensive manufacturing method.
 2. Labor-intensive manufacturing method.
- b. Determine the annual unit volume at which Sharpie is indifferent between the two manufacturing methods.
- c. Management wants to know more about the effect of each alternative on operating leverage.
 1. Explain operating leverage and the relationship between operating leverage and the volatility of earnings.
 2. Compute operating leverage for each alternative at a volume of 250,000 units.
 3. Which alternative has the higher operating leverage? Why?

LO3, 5**E16-22. Contribution Income Statement and Operating Leverage**

Stateline Berry Farm harvests early-season blueberries for shipment throughout Michigan and Illinois in July. The blueberry farm is maintained by a permanent staff of 10 employees and seasonal workers who pick and pack the blueberries. The blueberries are sold in crates containing 100 individually packaged one-quart containers. Affixed to each one-quart container is the distinctive Stateline Berry Farm logo inviting buyers to "Enjoy the berry best blueberries in the world!" The selling price is \$90 per crate, variable costs are \$80 per crate, and fixed costs are \$280,000 per year. In the year 2017, Stateline Berry Farm sold 50,000 crates.

Required

- a. Prepare a contribution income statement for the year ended December 31, 2017.
- b. Determine the company's 2017 operating leverage.
- c. Calculate the percentage change in profits if sales decrease by 10 percent.
- d. Management is considering the purchase of several berry-picking machines. This will increase annual fixed costs to \$375,000 and reduce variable costs to \$77.50 per crate. Calculate the effect of this acquisition on operating leverage and explain any change.



E16-23. Multiple Product Break-Even Analysis

LO4

Joe's Tax Service prepares tax returns for low- to middle-income taxpayers. Its service operates January 2 through April 15 at a counter in a local grocery store. All jobs are classified into one of three categories: standard, multiform, and complex. Following is information for last year. Also, last year, the fixed cost of rent, utilities, and so forth were \$50,000.



	Standard	Multiform	Complex
Billing rate.....	\$50	\$125	\$250
Average variable costs	(30)	(75)	(150)
Average contribution margin.....	\$20	\$ 50	\$100
Number of returns prepared	1,750	500	250
	<u> </u>	<u> </u>	<u> </u>

Required

- Determine Joe's break-even dollar sales volume.
- Determine Joe's margin of safety in sales dollars.
- Prepare a profit-volume graph for Joe's Tax Service.

E16-24. Cost-Volume-Profit Relations: Missing Data

LO3

Following are data from 4 separate companies.

	Case A	Case B	Case C	Case D
Unit sales.....	1,200	800	?	?
Sales revenue.....	\$20,000	?	?	\$80,000
Variable cost per unit.....	\$ 10	\$ 1	\$ 12	?
Contribution margin.....	?	\$800	?	?
Fixed costs	\$ 7,000	?	\$82,000	?
Net income.....	?	\$450	?	?
Unit contribution margin.....	?	?	?	\$ 15
Break-even point (units)	?	?	4,000	2,000
Margin of safety (units).....	?	?	300	1,000

**Required**

Supply the missing data in each independent case.

E16-25. Cost-Volume-Profit Relations: Missing Data

LO3

Following are data from 4 separate companies.

	Case 1	Case 2	Case 3	Case 4
Sales revenue.....	\$120,000	\$100,000	?	?
Contribution margin.....	\$ 60,000	?	\$20,000	?
Fixed costs	\$ 40,000	?	?	?
Net income.....	?	\$ 5,000	\$12,000	?
Variable cost ratio.....	?	0.50	?	0.22
Contribution margin ratio.....	?	?	0.40	?
Break-even point (dollars)	?	?	?	\$25,000
Margin of safety (dollars).....	?	?	?	\$20,000

**Required**

Supply the missing data in each independent case.

LO6 E16-26. Customer-Level Planning

Circle K operates a number of convenience stores worldwide. Assume that an analysis of operating costs, customer sales, and customer patronage reveals the following:



Fixed costs per store	\$80,000.00/year
Variable cost ratio	0.80
Average sale per customer visit	\$15.00
Average customer visits per week	1.75
Customers as portion of city population	0.04

Required

Determine the city population required for a single Circle K to earn an annual profit of \$40,000.

LO6 E16-27. Multiple-Level Break-Even Analysis

Kucera Associates provides marketing services for a number of small manufacturing firms. Kucera receives a commission of 10 percent of sales. Operating costs are as follows:



Unit-level costs	\$0.04 per sales dollar
Sales-level costs.....	\$300 per sales order
Customer-level costs.....	\$900 per customer per year
Facility-level costs	\$60,000 per year

Required

- Determine the minimum order size in sales dollars for Kucera to break even on an order.
- Assuming an average customer places four orders per year, determine the minimum annual sales required to break even on a customer.
- What is the average order size in (b)?
- Assuming Kucera currently serves 100 customers, with each placing an average of four orders per year, determine the minimum annual sales required to break even.
- What is the average order size in (d)?
- Explain the differences in the answers to (a), (c), and (e).

Problems

P16-28. Profit Planning with Taxes

Rebounder Company produces a rebounding net that can be used for soccer, baseball and lacrosse. The net sells for \$40 per unit. Last year, the company manufactured and sold 20,000 nets to obtain an after-tax profit of \$54,000. Variable and fixed costs follow.

Variable Costs per Unit	Fixed Costs per Year		
Manufacturing	\$18	Manufacturing	\$ 80,000
Selling and administrative	9	Selling and administrative	30,000
Total	\$27	Total	\$110,000

Required

- Determine the tax rate the company paid last year.
- What unit sales volume is required to provide an after-tax profit of \$100,000?
- If the company reduces the unit variable cost by \$3 and increases fixed manufacturing costs by \$22,000, what unit sales volume is required to provide an after-tax profit of \$100,000?
- What assumptions are made about taxable income and tax rates in requirements (a) through (c)?

P16-29. Contribution Income Statement, Cost-Volume-Profit Graph, and Taxes**LO2, 3**

New York Tours (NYT) provides daily sightseeing tours that include transportation, admission to selected attractions, and lunch. Ticket prices are \$85 each. During June 2017, NYT provided 3,000 tours.

Variable Costs per Customer		Fixed Costs per Month	
Admission fees	\$30	Operations	\$25,000
Lunch	17	Selling and administration	15,000
Overhead.....	10		
Selling and administrative	8		
Total	<u>\$65</u>	Total	<u>\$40,000</u>

NYT is subject to an income tax rate of 40 percent.

Required

- Prepare a contribution income statement for June.
- Determine NYT's monthly break-even point in units.
- Determine NYT's margin of safety for June 2017.
- Determine the unit sales required for a monthly after-tax profit of \$15,000.
- Prepare a cost-volume-profit graph. Label the horizontal axis in units with a maximum value of 4,000. Label the vertical in dollars with a maximum value of \$300,000. Draw a vertical line on the graph for the current (3,000) unit level and label total variable costs, total fixed costs, and total before-tax profits at 3,000 units.

P16-30. High-Low Cost Estimation and Profit Planning**LO3, 4**

Comparative 2017 and 2018 income statements for Bismark Products Inc. follow:

BISMARCK PRODUCTS INC. Comparative Income Statements For Years Ending December 31, 2017 and 2018		
	2017	2018
Unit sales.....	6,000	11,000
Sales revenue.....	<u>\$78,000</u>	<u>\$143,000</u>
Expenses.....	(70,000)	(85,000)
Profit (loss).....	<u>\$ 8,000</u>	<u>\$ 58,000</u>

**Required**

- Determine the break-even point in units.
- Determine the unit sales volume required to earn a profit of \$12,000.

P16-31. CVP Analysis and Special Decisions**LO3, 4**

Smoothie Citrus Company buys a variety of citrus fruit from growers and then processes the fruit into a product line of fresh fruit, juices, and fruit flavorings. The most recent year's sales revenue was \$4,400,000. Variable costs were 60 percent of sales and fixed costs totaled \$1,400,000. Smoothie is evaluating two alternatives designed to enhance profitability.

- One staff member has proposed that Smoothie purchase more automated processing equipment. This strategy would increase fixed costs by \$300,000 but decrease variable costs to 54 percent of sales.
- Another staff member has suggested that Smoothie rely more on outsourcing for fruit processing. This would reduce fixed costs by \$300,000 but increase variable costs to 65 percent of sales.

**Required**

- What is the current break-even point in sales dollars?
- Assuming an income tax rate of 34 percent, what dollar sales volume is currently required to obtain an after-tax profit of \$500,000?
- In the absence of income taxes, at what sales volume will both alternatives (automation and outsourcing) provide the same profit?
- Briefly describe one strength and one weakness of both the automation and the outsourcing alternatives.

LO3 P16-32. Break-Even Analysis in a Not-for-Profit Organization

Melford Hospital operates a general hospital but rents space to separately owned entities rendering specialized services such as pediatrics and psychiatry. Melford charges each separate entity for patients' services (meals and laundry) and for administrative services (billings and collections). Space and bed rentals are fixed charges for the year, based on bed capacity rented to each entity. Melford charged the following costs to Pediatrics for the year ended June 30, 2017:

	Patient Services (Variable)	Bed Capacity (Fixed)
Dietary	\$ 600,000	
Janitorial		\$ 70,000
Laundry	300,000	
Laboratory	450,000	
Pharmacy	350,000	
Repairs and maintenance		30,000
General and administrative		1,300,000
Rent		1,500,000
Billings and collections	300,000	
Total	<u><u>\$2,000,000</u></u>	<u><u>\$2,900,000</u></u>

In addition to these charges from Melford Hospital, Pediatrics incurred the following personnel costs:

	Annual Salaries*
Supervising nurses	\$100,000
Nurses	200,000
Assistants	180,000
Total	<u><u>\$480,000</u></u>

* These salaries are fixed within the ranges of annual patient-days considered in this problem.

During the year ended June 30, 2017, Pediatrics charged each patient \$300 per day, had a capacity of 60 beds, and had revenues of \$6,000,000 for 365 days. Pediatrics operated at 100 percent capacity on 90 days during this period. It is estimated that during these 90 days, the demand exceeded 80 beds. Melford has 20 additional beds available for rent for the year ending June 30, 2018. This additional rental would proportionately increase Pediatrics' annual fixed charges based on bed capacity.

Required

- Calculate the minimum number of patient-days required for Pediatrics to break even for the year ending June 30, 2018, if the additional beds are not rented. Patient demand is unknown, but assume that revenue per patient-day, cost per patient-day, cost per bed, and salary rates for the year ending June 30, 2018, remain the same as for the year ended June 30, 2017.
- Assume Pediatrics rents the extra 20-bed capacity from Melford. Determine the net increase or decrease in earnings by preparing a schedule of increases in revenues and costs for the year ending June 30, 2018. Assume that patient demand, revenue per patient-day, cost per patient-day, cost per bed, and salary rates remain the same as for the year ended June 30, 2017.

(CPA adapted)

LO3 P16-33. CVP Analysis of Alternative Products

Pegasus Shoe Company plans to expand its manufacturing capacity to allow up to 20,000 pairs of a new product each year. Because only one product can be produced, management is deciding between the production of the Roadrunner for backpacking and the Trail Runner for exercising. A marketing analysis indicates Pegasus could sell between 8,000 and 14,000 pairs of either product.

The accounting department has developed the following price and cost information:

	Product	
	Roadrunner	Trail Runner
Selling price per pair	\$ 90	\$ 75
Variable costs per pair	60	50
Product costs	<u><u>\$130,000</u></u>	<u><u>\$50,000</u></u>

Facility costs for expansion, regardless of product, are \$150,000. Pegasus is subject to a 40 percent income tax rate.

Required

- a. Determine the number of pairs of Roadrunner shoes Pegasus must sell to obtain an after-tax profit of \$30,000.
- b. Determine the number of pairs of each product Pegasus must sell to obtain identical before-tax profit.
- c. For the solution to requirement *b*, calculate Pegasus' after-tax profit or loss.
- d. Which product should Pegasus produce if both products were guaranteed to sell at least 13,000 pairs? Verify your solution with calculations.
- e. How much would the variable costs per pair of the product *not* selected in requirement *d* have to fall before both products provide the same profit at sales of 13,000 pairs? Verify your solution with calculations.

P16-34. CVP Analysis Using Published Financial Statements

Condensed data in millions of dollars from [Apple's](#) 2014 and 2015 income statements follow:

	2015	2014
Revenues.....	\$233,715	\$182,795
Total cost of revenues and operating expenses.....	<u>(162,485)</u>	<u>(130,292)</u>
Operating income.....	<u><u>\$ 71,230</u></u>	<u><u>\$ 52,503</u></u>

Required

- a. Develop a cost-estimation equation for Apple's annual cost of revenues and operating expenses.
- b. Determine Apple's annual break-even point.
- c. Predict operating profit for 2016, assuming 2016 sales of \$284,000 million.
- d. Identify the assumptions required to use the equations and amounts computed above.

P16-35. Multiple-Product Profitability Analysis, Multiple-Level Profitability Analysis

College Avenue Bookstore sells new college textbooks at the publishers' suggested retail prices. It then pays the publishers an amount equal to 75 percent of the suggested retail price. The store's other variable costs average 5 percent of sales revenue and annual fixed costs amount to \$360,000.

LO6

Required

- a. Determine the bookstore's annual break-even point in sales dollars.
- b. Assuming an average textbook has a suggested retail price of \$120, determine the bookstore's annual break-even point in units.
- c. College Avenue Bookstore is planning to add used book sales to its operations. A typical used book costs the store 25 percent of the suggested retail price of a new book. The bookstore plans to sell used books for 75 percent of the suggested retail price of a new book. Assuming unit sales are unchanged, describe the effect on bookstore profitability of shifting sales toward more used and fewer new textbooks.
- d. College Publishing produces and sells new textbooks to college and university bookstores. Typical project-level costs total \$325,000 for a new textbook. Production and distribution costs amount to 20 percent of the net amount the publisher receives from the bookstores. Textbook authors are paid a royalty of 15 percent of the net amount received from the bookstores. Determine the dollar sales volume required for College Publishing to break even on a new textbook. This is the amount the bookstore pays the publisher, not the bookstore's sales revenue.
- e. For a project with predicted sales of 8,000 new books at \$120 each, determine:
 1. The bookstores' contribution.
 2. The publisher's contribution.
 3. The author's royalties.

LO3, 4 P16-36. Multiple-Product Profitability Analysis

SKYZ Company produces two models of basketball hoops, Ausom Garage Mount and Delux Ground Mount. Presented is sales information for the year 2017.

	Ausom	Delux	Total
Units manufactured and sold	1,000	1,500	2,500
Sales revenue.....	\$300,000	\$700,000	\$1,000,000
Variable costs.....	(200,000)	(420,000)	(620,000)
Contribution margin.....	<u>\$100,000</u>	<u>\$280,000</u>	<u>380,000</u>
Fixed costs			(252,510)
Before-tax profit			127,490
Income taxes (40 percent).....			(50,996)
After-tax profit			<u>\$ 76,494</u>

Required

- Determine the current break-even point in sales dollars.
- With the current product mix and break-even point, determine the average unit contribution margin and unit sales.
- Sales representatives believe that the total sales will increase to 3,000 units, with the sales mix likely shifting to 80 percent Ausom Garage Mount and 20 percent Delux Ground Mount over the next few years. Evaluate the desirability of this projection.

LO3, 4 P16-37. Multiple-Product Break-Even Analysis

Currently, Corner Lunch Counter sells only Super Burgers for \$2.50 each. During a typical month, the Counter reports a profit of \$9,000 with sales of \$50,000 and fixed costs of \$21,000. Management is considering the introduction of a new Super Chicken Sandwich that will sell for \$3.50 and have variable costs of \$2.30. The addition of the Super Chicken Sandwich will require hiring additional personnel and renting additional equipment. These actions will increase monthly fixed costs by \$7,760.

In the short run, management predicts that Super Chicken sales will average 10,000 sandwiches per month. However, almost all short-run sales of Super Chickens will come from regular customers who switch from Super Burgers to Super Chickens. Consequently, management predicts monthly sales of Super Burgers will decline by 10,000 units to \$25,000. In the long run, management predicts that Super Chicken sales will increase to 15,000 sandwiches per month and that Super Burger sales will increase to 30,000 burgers per month.

Required

- Determine each of the following:
 - The current monthly break-even point in sales dollars.
 - The short-run monthly profit and break-even point in sales dollars subsequent to the introduction of Super Chickens.
 - The long-run monthly profit and break-even point in sales dollars subsequent to the introduction of Super Chickens.
- Based on your analysis, what are your recommendations?

LO6 P16-38. Multi-Level Profitability Analysis

AccuMeter manufactures and sells its only product (Z1) in lot sizes of 500 units. Because of this approach, lot (batch)-level costs are regarded as variable for CVP analysis. Presented is sales and cost information for the year 2017:

Sales revenue (50,000 units at \$45)	\$2,250,000
Direct materials (50,000 units at \$12).....	600,000
Processing (50,000 units at \$18).....	900,000
Setup (100 lots at \$2,000).....	200,000
Batch movement (100 lots at \$400).....	40,000
Order filling (100 lots at \$200).....	20,000
Fixed manufacturing overhead.....	800,000
Fixed selling and administrative.....	300,000

Required

- a. Prepare a traditional contribution income statement in good form.
- b. Prepare a multi-level contribution income statement in good form. (*Hint:* First determine the appropriate cost hierarchy.)
- c. What is the current contribution per lot (batch) of 500 units?
- d. Management is contemplating introducing a limited number of specialty products. One product would sell for \$65 per unit and have direct materials costs of \$17 per unit. All other costs and all production and sales procedures will remain unchanged. What lot (batch) size is required for a contribution of \$700 per lot?

Management Applications

MA16-39. Ethics and Pressure to Improve Profit Plans**LO1**

Art Conroy is the assistant controller of New City Muffler, Inc., a subsidiary of New City Automotive, which manufactures tailpipes, mufflers, and catalytic converters at several plants throughout North America. Because of pressure for lower selling prices, New City Muffler has had disappointing financial performance in recent years. Indeed, Conroy is aware of rumblings from corporate headquarters threatening to close the plant.

One of Conroy's responsibilities is to present the plant's financial plans for the coming year to the corporate officers and board of directors. In preparing for the presentation, Conroy was intrigued to note that the focal point of the budget presentation was a profit-volume graph projecting an increase in profits and a reduction in the break-even point.

Curious as to how the improvement would be accomplished, Conroy ultimately spoke with Paula Mitchell, the plant manager. Mitchell indicated that a planned increase in productivity would reduce variable costs and increase the contribution margin ratio.

When asked how the productivity increase would be accomplished, Mitchell made a vague reference to increasing the speed of the assembly line. Conroy commented that speeding up the assembly line could lead to labor problems because the speed of the line was set by union contract. Mitchell responded that she was afraid that if the speedup were opened to negotiation, the union would make a big "stink" that could result in the plant being closed. She indicated that the speedup was the "only way to save the plant, our jobs, and the jobs of all plant employees." Besides, she did not believe employees would notice a 2 or 3 percent increase in speed. Mitchell concluded the meeting observing, "You need to emphasize the results we will accomplish next year, not the details of how we will accomplish those results. Top management does not want to be bored with details. If we accomplish what we propose in the budget, we will be in for a big bonus."

Required

What advice do you have for Art Conroy?

MA16-40. CVP Analysis with Changing Cost Structure**LO1, 3, 5**

Homestead Telephone was formed in the 1940s to bring telephone services to remote areas of the U.S. Midwest. The early equipment was quite primitive by today's standards. All calls were handled manually by operators, and all customers were on party lines. By the 1970s, however, all customers were on private lines, and mechanical switching devices handled routine local and long distance calls. Operators remained available for directory assistance, credit card calls, and emergencies. In the 1990s Homestead Telephone added local Internet connections as an optional service to its regular customers. It also established an optional cellular service, identified as the Home Ranger.

Required

- a. Using a unit-level analysis, develop a graph with two lines, representing Homestead Telephone's cost structure (1) in the 1940s and (2) in the late 1990s. Be sure to label the axes and lines.
- b. With sales revenue as the independent variable, what is the likely impact of the changed cost structure on Homestead Telephone's (1) contribution margin percent and (2) break-even point?
- c. Discuss how the change in cost structure affected Homestead's operating leverage and how this affects profitability under rising or falling sales scenarios.

LO2, 3, 4 MA16-41. Cost Estimation and CVP Analysis

Presented are the 2017 and 2018 functional income statements of Regional Distribution Inc.:

REGIONAL DISTRIBUTION INC. Functional Income Statements For Years Ending December 31, 2017 and 2018			
	2017	2018	
Sales.....	\$2,760,000		\$2,500,000
Expenses			
Cost of goods sold	\$2,070,000		\$1,875,000
Shipping	107,700		100,000
Sales order processing.....	26,250		25,000
Customer relations.....	60,000		50,000
Depreciation.....	40,000		40,000
Administrative	125,000	(2,428,950)	125,000
			<u>(2,215,000)</u>
Before-tax profit	331,050		285,000
Income taxes (40%).....	(132,420)		(114,000)
			<u>\$ 171,000</u>
After-tax profit	<u>\$ 198,630</u>		

Required

- Determine Regional Distribution's break-even point in sales dollars.
- What dollar sales volume is required to earn an after-tax profit of \$480,000?
- Assuming budgeted 2017 sales of \$6,000,000, prepare a 2017 contribution income statement.
- Discuss the reliability of the calculations in requirements *a-c*, including the limitations of the CVP model and how they affect the reliability of the model.

Solutions to Review Problems**Review 16-1—Solution**

- $\text{Profit} = \$14X - (\$10,000 + 5.25X)$
- At a volume of 6,200 cartons, Benchmark's profit is \$44,250.
Computed as $(\$14 \times 6,200) - [\$10,000 + (\$5.25 \times 6,200)]$
 $\$86,800 - \$42,550 = \$44,250$

Review 16-2—Solution

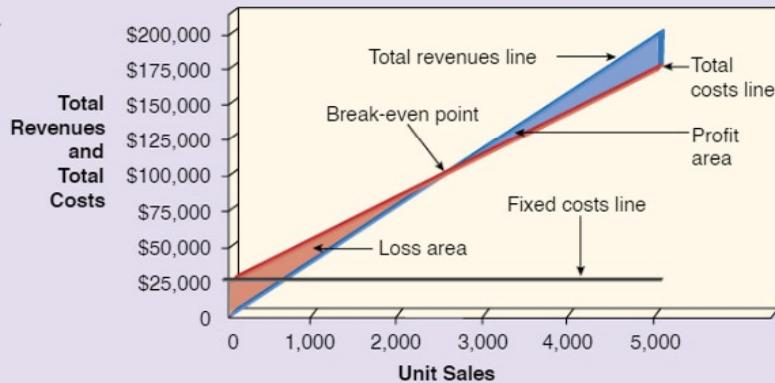
a. SOLO CUP COMPANY Contribution Income Statement For the Month of September 2017		
Sales (3,000 × \$40)		\$120,000
Less variable costs		
Direct materials (3,000 × \$15)	\$45,000	
Direct labor (3,000 × \$3).....	9,000	
Manufacturing overhead (3,000 × \$10).....	30,000	
Selling and administrative (3,000 × \$2).....	6,000	<u>(90,000)</u>
Contribution margin.....		30,000
Less fixed costs		
Manufacturing overhead	15,000	
Selling and administrative	10,000	<u>(25,000)</u>
Profit.....		<u>\$ 5,000</u>

b.	Selling price	\$40 per unit
	Variable costs.....	(30) per unit
	Contribution margin.....	\$10 per unit =====

$$\begin{aligned}\text{Contribution margin ratio} &= \frac{\text{Unit contribution margin}}{\text{Unit selling price}} \\ &= \$10 \div \$40 \\ &= 0.25\end{aligned}$$

Review 16-3—Solution

a.



b.

$$\begin{aligned}\text{Break-even point} &= \frac{\text{Fixed costs}}{\text{Unit contribution margin}} \\ &= \$25,000 \div \$10 \\ &= 2,500 \text{ units}\end{aligned}$$

c.

$$\begin{aligned}\text{Required dollar sales} &= \frac{\text{Fixed costs} + \text{Desired profit}}{\text{Contribution margin ratio}} \\ &= (\$25,000 + \$5,000) \div 0.25 \\ &= \$120,000\end{aligned}$$

d.

$$\begin{aligned}\text{Required unit sales} &= \frac{\text{Fixed costs} + \text{Desired before-tax profit}}{\text{Unit contribution margin}} \\ \text{Desired before-tax profit} &= \$4,500 \div (1 - 0.40) = \$7,500 \\ \text{Required unit sales} &= (\$25,000 + \$7,500) \div \$10 \\ &= 3,250 \text{ units}\end{aligned}$$

Review 16-4—Solution

a.		Coffee	Tea	Smoothies	Total
Monthly unit sales.....	6,000	3,750	2,250		
Selling price	<u><u>\$1.35</u></u>	<u><u>\$1.25</u></u>	<u><u>\$1.95</u></u>		
Sales.....	<u><u>\$8,100.00</u></u>	<u><u>\$4,687.50</u></u>	<u><u>\$4,387.50</u></u>	<u><u>\$17,175.00</u></u>	
Variable costs.....	<u><u>3,600.00</u></u>	<u><u>1,687.50</u></u>	<u><u>1,687.50</u></u>	<u><u>6,975.00</u></u>	
Contribution margin	<u><u>\$4,500.00</u></u>	<u><u>\$3,000.00</u></u>	<u><u>\$2,700.00</u></u>	<u><u>10,200.00</u></u>	
Fixed costs				<u><u>8,000.00</u></u>	
Before-tax profit				<u><u>\$ 2,200.00</u></u>	
Contribution margin (CM) ratio	<u><u>0.5556</u></u>	<u><u>0.6400</u></u>	<u><u>0.6154</u></u>	<u><u>0.5939</u></u>	
Current sales mix (based on sales dollars)...	<u><u>47.16%</u></u>	<u><u>27.29%</u></u>	<u><u>25.55%</u></u>		

b.

$$\text{Break-even} = \text{Fixed costs} / \text{Total contribution margin ratio}$$

$$= \$8,000 / 0.5939$$

$$= \$13,470$$

Proof:	Sales	C/M Ratio
Coffee: $\$13,470 \times 47.16\% = \$ 6,352.45$	$\times 0.5556 = \$3,529.42$	
Tea: $\$13,470 \times 27.29\% = 3,675.96$	$\times 0.6400 = 2,352.62^*$	
Smoothies: $\$13,470 \times 25.55\% = 3,441.59$	$\times 0.6154 = 2,117.96^*$	
	<u><u>$\\$13,470.00$</u></u>	
Total contribution margin....		8,000.00
Fixed costs		8,000.00
Before-tax profit		<u><u>-0-</u></u>

* Amounts adjusted to correct for minor rounding error.

Review 16-5—Solution

The Coffee Bean has an operating leverage of 4.636, calculated as a contribution margin of \$10,200 divided by before-tax profit of \$2,200. Therefore, if sales dollars increase by 20% to \$20,610, before-tax profit should increase by 4.636 times 20%, or 92.72%, to \$4,240. Because of the leverage caused by fixed costs, a 20% increase in sales results in a 92.72% increase in before-tax profit. Conversely, a 20% decrease in sales would result in a 92.72% decrease in before-tax profits to \$160.

Proof:	20% Sales Increase	20% Sales Decrease
Sales.....	$\$20,610$	$\$13,740$
CM %.....	$\times 0.5939$	$\times 0.5939$
Total CM.....	12,240	8,160
Fixed costs	<u><u>8,000</u></u>	<u><u>8,000</u></u>
Before-tax profit	<u><u>$\\$ 4,240$</u></u>	<u><u>$\\$ 160$</u></u>

Current before-tax profit of $\$2,200 \times (1 + 0.9272) = \$4,240$

Current before-tax profit of $\$2,200 \times (1 - 0.9272) = \160

Review 16-6—Solution

Weekly contribution per average customer:

$$\$17 \text{ sales per visit} \times (1 - 0.80) \text{ contribution ratio} \times 1.50 \text{ visits} = \$5.10$$

$$\text{Annual contribution per customer} = \$5.10 \times 52 \text{ weeks} = \$265.20$$

$$\text{Customers required for desired profit} = (\$80,000 + \$40,000) / \$265.20 = 453 \text{ (rounded up to the next whole number)}$$

$$\text{Required population} = 453 \text{ customers} / 0.05 \text{ customers in population} = 9,060$$

