

Cost-Volume-Profit Analysis

► In Brief

Managers need to estimate future revenues, costs, and profits to help them plan and monitor operations. They use cost-volume-profit (CVP) analysis to identify the levels of operating activity needed to avoid losses, achieve targeted profits, plan future operations, and monitor organizational performance. Managers also analyze operational risk as they choose an appropriate cost structure.

This Chapter Addresses the Following Questions:

- Q1** What is cost-volume-profit (CVP) analysis, and how is it used for decision making?
- Q2** How are CVP calculations performed for a single product?
- Q3** How are CVP calculations performed for multiple products?
- Q4** What is the breakeven point?
- Q5** What assumptions and limitations should managers consider when using CVP analysis?
- Q6** How are margin of safety and operating leverage used to assess operational risk?

COLECO: FAULTY FORECASTS

In the early 1980s, personal computers were still somewhat a novelty. At that time, Coleco manufactured a small computer called Adam. In addition, it sold Colecovision games for home computers. Coleco marketed Adam and its computer games heavily, hoping in 1982 for a hot seller during the Christmas and holiday gift season. However, Adam and Colecovision did not sell well. Coleco found itself close to bankruptcy.

Then in 1983 Coleco purchased the license to manufacture Cabbage Patch Dolls. It began production for Christmas 1983. Coleco widely publicized the dolls' arrival at toy stores, but managers anticipated greater sales of Adam in their production schedules. They did not emphasize production of the Cabbage Patch Dolls. These dolls became hot sellers that Christmas, and inventories were depleted rapidly. The scarcity generated so much interest that customers fought



with each other for the dolls and even wrecked some toy stores while trying to purchase Cabbage Patch Dolls for the holidays. Because of the shortage, advertising for the dolls was canceled shortly after their introduction.

Coleco's managers continued to think that the company's reputation would be based on computers. However, Cabbage Patch Dolls became their most successful product for the next several years. After success with Cabbage Patch Dolls and action figure toys called Masters of the Universe, Coleco continued to aim for hot sellers. This strategy involved a great deal of uncertainty, and by

1988 the company was bankrupt. ■

SOURCES: L. Brannon and A. McCabe, "Time-Restricted Sales Appeals," *Cornell Hotel and Restaurant Administration Quarterly*, August/September 2001, pp. 47–53; and K. Fitzgerald, "Toys Face Scrooge-Like Christmas," *Advertising Age*, September 19, 1988, pp. 30–32.

DETERMINING A PROFITABLE MIX OF PRODUCTS

■ Key Decision Factors for Coleco

What went wrong with **Coleco's** decision to emphasize production of Adam instead of Cabbage Patch Dolls? The problems began with uncertainties about which products would be popular at Christmas. Coleco's managers could not know which products would sell best. Nevertheless, it was necessary for them to make decisions about the types and volumes of products to manufacture. They forecast the number and type of products that would sell and then made production decisions accordingly. The following discussion summarizes key issues in Coleco's decision-making process.

Knowing. Knowledge about consumer markets, competition, production processes, and costs were critical when Coleco's managers decided which product to emphasize. Coleco needed this knowledge for its potential markets—dolls, computers, and games. Given the company's experience, its knowledge was probably greater for producing Adam than for Cabbage Patch Dolls. However, doll manufacturing was a relatively simple process compared to producing computers.

Identifying. Companies commonly face major uncertainties in their product markets, particularly in the toy industry where competition is often fierce and consumer tastes change rapidly. However, Coleco's uncertainties were greater than most because of the relatively new—and competitive—computer market. For example, the managers did not know:

- How quickly consumers would embrace computers
- What would persuade consumers to purchase a first computer
- How quickly computer technology and competition would change
- Exactly how much the computers would cost to produce

Exploring. Coleco's managers faced a difficult task in adequately exploring their decision to emphasize Adam over Cabbage Patch Dolls. However, thorough analysis is crucial for this type of decision. For example, the managers needed to do the following:

- Anticipate which product would sell best. Although market research helps managers estimate product demand, they would still have considerable uncertainty about actual product sales.
- Avoid biased forecasts and analyses. Managers often have emotional attachments to sunk costs, such as the large investment already made in Adam, that should not affect decision making.
- Consider risks associated with the cost structure for each product. Compared to Adam, Cabbage Patch dolls probably had lower fixed costs and a greater proportion of variable costs. When more of a product's costs are variable, profit is less risky because the sales volumes needed to cover fixed costs are relatively lower. Cabbage Patch may have carried less operating risk than Adam.

Prioritizing. Given limited resources and their analyses of expected profit from the two products, Coleco's managers decided to prioritize production of Adam over Cabbage Patch Dolls. This decision might have been clouded by management biases, as already discussed.

Envisioning. Despite previous poor sales of Adam, Coleco's managers continued promoting the product. In hindsight, it is easy to criticize the company for this strategy; however, it would have been difficult for Coleco's managers to adequately estimate product sales. Later, the managers adopted an ongoing strategy of seeking hot-selling toys. This strategy ultimately failed.

■ Decision Making Using Information about Revenues and Costs

Because **Coleco's** managers overestimated Adam sales and underestimated Cabbage Patch Doll sales, they not only incurred substantial losses on the Adam line, but also lost the opportunity to gain more profit by selling additional Cabbage Patch Dolls. In Chapter 2, we focused primarily on the estimation of costs. However, managers combine information about revenues and costs to help them decide the mix and volumes of goods or services to produce

and sell. They also use this information to monitor operations and evaluate profitability risk. In this chapter, we combine revenues and costs in our analyses.

COST-VOLUME-PROFIT ANALYSIS

Q1 What is cost-volume-profit (CVP) analysis, and how is it used for decision making?

Q2 How are CVP calculations performed for a single product?

Cost-volume-profit (CVP) analysis is a technique that examines changes in profits in response to changes in sales volumes, costs, and prices. Accountants often perform CVP analysis to plan future levels of operating activity and provide information about:

- Which products or services to emphasize
- The volume of sales needed to achieve a targeted level of profit
- The amount of revenue required to avoid losses
- Whether to increase fixed costs
- How much to budget for discretionary expenditures
- Whether fixed costs expose the organization to an unacceptable level of risk

Profit Equation and Contribution Margin

CVP analysis begins with the basic profit equation.

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

Separating costs into variable and fixed categories, we express profit as:

$$\text{Profit} = \text{Total revenue} - \text{Total variable costs} - \text{Total fixed costs}$$

The **contribution margin** is total revenue minus total variable costs. Similarly, the **contribution margin per unit** is the selling price per unit minus the variable cost per unit. Both contribution margin and contribution margin per unit are valuable tools when considering the effects of volume on profit. Contribution margin per unit tells us how much revenue from each unit sold can be applied toward fixed costs. Once enough units have been sold to cover all fixed costs, then the contribution margin per unit from all remaining sales becomes profit.

If we assume that the selling price and variable cost per unit are constant, then total revenue is equal to price times quantity, and total variable cost is variable cost per unit times quantity. We then rewrite the profit equation in terms of the contribution margin per unit.

$$\text{Profit} = P \times Q - V \times Q - F = (P - V) \times Q - F$$

where

P = Selling price per unit

V = Variable cost per unit

$(P - V)$ = Contribution margin per unit

Q = Quantity of product sold (units of goods or services)

F = Total fixed costs

We use the profit equation to plan for different volumes of operations. CVP analysis can be performed using either:

- Units (quantity) of product sold
- Revenues (in dollars)

CVP Analysis in Units

We begin with the preceding profit equation. Assuming that fixed costs remain constant, we solve for the expected quantity of goods or services that must be sold to achieve a target level of profit.

Profit equation: $\text{Profit} = (P - V) \times Q - F$

Solving for Q: $Q = \frac{F + \text{Profit}}{(P - V)} = \text{Quantity (units) required to obtain target profit}$

Notice that the denominator in this formula, $(P - V)$, is the contribution margin per unit.

CURRENT PRACTICE

According to Jon Scheumann, director of the business process consulting firm [Gunn Partners](#), successful organizations need a culture that is attuned to cost management and that pays attention to cost structures.¹

¹Editorial, "A Proactive Approach to Cost Cutting," *SmartPros*, June 2002, www.smartpros.com.

90 CHAPTER 3 ► COST-VOLUME-PROFIT ANALYSIS

Suppose that Magik Bicycles wants to produce a new mountain bike called Magikbike III and has forecast the following information.

Price per bike = \$800
 Variable cost per bike = \$300
 Fixed costs related to bike production = \$5,500,000
 Target profit = \$200,000
 Estimated sales = 12,000 bikes

We determine the quantity of bikes needed for the target profit as follows:

$$\text{Quantity} = (\$5,500,000 + \$200,000) \div (\$800 - \$300) = 11,400 \text{ bikes}$$

■ CVP Analysis in Revenues

The **contribution margin ratio (CMR)** is the percent by which the selling price (or revenue) per unit exceeds the variable cost per unit, or contribution margin as a percent of revenue. For a single product, it is

$$\text{CMR} = \frac{P - V}{P}$$

To analyze CVP in terms of total revenue instead of units, we substitute the contribution margin ratio for the contribution margin per unit. We rewrite the equation to solve for the total dollar amount of revenue we need to cover fixed costs and achieve our target profit as

$$\text{Revenue} = \frac{F + \text{Profit}}{(P - V)/P} = \frac{F + \text{Profit}}{\text{CMR}}$$

To solve for the Magikbike III revenues needed for a target profit of \$200,000, we first calculate the contribution margin ratio as follows:

$$\text{CMR} = (\$800 - \$300) \div \$800 = 0.625$$

A contribution margin ratio of 0.625 means that 62.5% of the revenue from each bike sold contributes first to fixed costs and then to profit after fixed costs are covered.

$$\text{Revenue} = (\$5,500,000 + \$200,000) \div 0.625 = \$9,120,000$$

We check to see that the two results are identical by multiplying the number of units (11,400) times price (\$800) to obtain the revenue amount (\$9,120,000).

The contribution margin ratio can also be written in terms of total revenues (TR) and total variable costs (TVC). That is, for a single product, the CMR is the same whether we compute it using per-unit selling price and variable cost or using total revenues and total variable costs. Thus, we can create the following mathematically equivalent version of the CVP formula.

$$\text{Revenues} = \frac{F + \text{Profit}}{(\text{TR} - \text{TVC})/\text{TR}}$$

For Magikbike III we could use the forecast information about volume (12,000 bikes) to determine the contribution margin ratio.

Total revenue = \$800 × 12,000 bikes = \$9,600,000
 Total variable cost = \$300 × 12,000 bikes = \$3,600,000
 Total contribution margin = \$9,600,000 − \$3,600,000 = \$6,000,000
 Contribution margin ratio = \$6,000,000 ÷ \$9,600,000 = 0.625

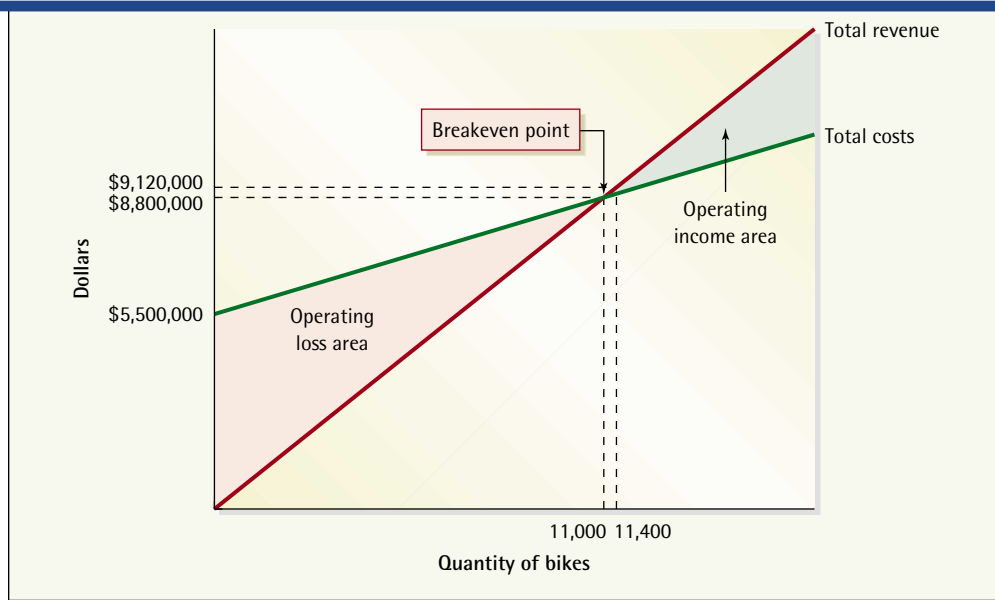
■ CVP for Multiple Products

Many organizations sell a combination of different products or services. The **sales mix** is the proportion of different products or services that an organization sells. For example, we learned in the opening vignette that **Coleco** sold both Adam computers and Cabbage Patch dolls. To use CVP in the case of multiple products or services, we assume a constant sales mix in addition to the other CVP assumptions. Assuming a constant sales mix allows CVP computations to be performed using combined unit or revenue data for an organization as a whole. Later in the chapter we will learn how to perform detailed computations for the sales mix.

HELPFUL HINT

Computing the CVP using total revenues and total variable costs is useful in cases where per-unit variable costs are unknown.

EXHIBIT 3.1
CVP Graph for Magik Bicycles' Magikbike III.



Q4 What is the breakeven point?

CURRENT PRACTICE

The [U.S. Small Business Administration](#) Web site recommends the use of breakeven analysis and refers small business owners to a breakeven analysis calculator and CVP graphing tool.²

■ Breakeven Point

Managers often want to know the level of activity required to break even. A CVP analysis can be used to determine the **breakeven point**, or level of operating activity at which revenues cover all fixed and variable costs, resulting in zero profit. We can calculate the breakeven point from any of the preceding CVP formulas, setting profit to zero. Depending on which formula we use, we calculate the breakeven point in either number of units or in total revenues. For Magikbike III, breakeven points are:

$$\begin{aligned} \text{Breakeven quantity} &= (\$5,500,000 + \$0) \div (\$800 - \$300) = 11,000 \text{ bikes} \\ \text{Breakeven revenue} &= (\$5,500,000 + \$0) \div 0.625 = \$8,800,000 \end{aligned}$$

■ Cost-Volume-Profit Graph

A **cost-volume-profit graph** (or CVP graph) shows the relationship between total revenues and total costs; it illustrates how an organization's profits are expected to change under different volumes of activity. Exhibit 3.1 presents a CVP graph for Magikbikes III. Notice that when no bikes are sold, fixed costs are \$5,500,000, resulting in a loss of \$5,500,000. As sales volume increases, the loss decreases by the contribution margin for each bike sold. The cost and revenue lines intersect at the breakeven point of 11,000, which means zero loss and zero profit. Then as sales increase beyond this breakeven point, we see an increase in profit, growing by the \$500 contribution margin for each bike sold. Profits achieve the target level of \$200,000 when sales volume reaches 11,400.

GUIDE YOUR LEARNING 3.1 Key Terms

Stop to confirm that you understand the new terms introduced in the last several pages.

- | | |
|---|----------------------------------|
| Cost-volume-profit (CVP) analysis (p. 89) | *Sales mix (p. 90) |
| Contribution margin (p. 89) | Breakeven point (p. 91) |
| Contribution margin per unit (p. 89) | Cost-volume-profit graph (p. 91) |
| Contribution margin ratio (CMR) (p. 90) | |

For each of these terms, write a definition in your own words. For the starred term, list at least one example that is different from the ones given in this textbook.

²Do a search for Breakeven Analysis at the U.S. Small Business Administration Web site, available at www.sba.gov.

■ CVP with Income Taxes

ALTERNATIVE TERMS

Some people use the terms *operating income (loss)* or *income (loss) before income taxes* instead of *pretax profit (loss)*. Similarly, some people use *net income (loss)* instead of *after-tax profit (loss)*.

Up to this point, our CVP calculations ignored income taxes. An organization's after-tax profit is calculated by subtracting income tax from pretax profit. The tax is usually calculated as a percentage of pretax profit.

$$\begin{aligned} \text{After-tax profit} &= \text{Pretax profit} - \text{Taxes} \\ &= \text{Pretax profit} - (\text{Tax rate} \times \text{Pretax profit}) \\ &= \text{Pretax profit} \times (1 - \text{Tax rate}) \end{aligned}$$

If we want to know the amount of pretax profit needed to achieve a target level of after-tax profit, we solve the preceding formula for pretax profit:

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

Suppose that Magik Bicycles plans for an after-tax profit of \$20,000 and its tax rate is 30%. Then,

$$\text{Pretax profit} = \$20,000 \div (1 - 0.30) = \$28,571$$

The company needs a pretax profit of \$28,571 to earn an after-tax profit of \$20,000.

The following illustration develops a cost function to calculate the volumes needed to break even and to achieve a target after-tax profit when multiple products are involved.



DIE GEFLECKTE KUH EIS (THE SPOTTED COW CREAMERY) (PART 1) CVP ANALYSIS WITH INCOME TAXES

Die Gefleckte Kuh Eis (The Spotted Cow Creamery) is a popular ice cream emporium near a university in Munich, Germany. Information for the most recent month (amounts in euros) appears here.

Revenue	40,000
Cost of food and beverages sold	20,000
Labor	15,000
Rent	1,000
	4,000
Pretax profit	4,000
Income taxes (25%)	1,000
	3,000
After-tax profit	

The store owner asked the manager, Holger Soderstrom, to estimate results for the next month. This particular outlet has not performed as well as the owner's other three outlets. Holger believes that sales volumes will increase to 48,000 next month because it has been an unusually hot and dry summer.

Estimating the Cost Function

To perform CVP analysis, Holger first estimates the cost function. Using accounting records, he classifies each cost as fixed or variable and then estimates next month's cost. Of the costs listed in the accounting records, labor (15,000) and rent (1,000) are most likely fixed (assuming employees work fixed schedules). Assuming that fixed costs do not change from month to month, Holger's best estimate of next month's fixed costs is 16,000 (15,000 + 1,000). The remaining item, cost of food and beverages sold (20,000), is most likely a variable cost. Because The Spotted Cow Creamery's focus is retail sales of ice cream and other food items, Holger can reasonably assume that sales volume drives this variable cost. Thus, he estimates expected variable costs as a percent of revenue:

$$20,000 \div 40,000 = 0.50, \text{ or } 50\% \text{ of revenue}$$

Holger combines his fixed and variable cost estimates to create the following cost function for next month:

$$TC = 16,000 + (50\% \times \text{Revenues})$$

Estimating After-Tax Profit

If next month's revenues are 48,000, Holger expects total variable costs to be (50% × 48,000) = 24,000. Therefore, his estimate of pretax profit is

$$\text{Pretax profit} = 48,000 - 16,000 - 24,000 = 8,000$$

Holger estimates income taxes and after-tax profit, assuming that income taxes remain at 25% of pretax profit:

$$\text{After-tax profit} = 8,000(1 - 0.25) = 6,000$$

Calculating Revenues to Achieve Targeted After-Tax Profit

Holger presents the preceding information to the owner. However, the owner still has concerns about this outlet because the other outlets have achieved after-tax profits of about 8,000 each during the last few months. The owner thinks that sales volume might be the problem. To help analyze this possibility, Holger determines the sales volume necessary to earn after-tax profits of 8,000 per month. He begins by calculating the targeted pretax profit:

$$\text{Pretax profit} = 8,000 \div (1 - 0.25) = 10,667$$

Next, he uses the following CVP formula to solve for targeted revenue:

$$\text{Revenues} = \frac{F + \text{Profit}}{\text{CMR}}$$

Substituting in the preceding information:

$$\text{Revenues} = (16,000 + 10,667) \div 0.50 = 53,334$$

Notice that Holger uses the contribution margin ratio calculated with the sales revenue and variable costs from his original analysis.

Holger summarizes his target profit calculations for the owner as follows:

Revenue	53,334
Cost of food and beverages sold (50% of 53,334)	26,667
Labor (fixed)	15,000
Rent (fixed)	1,000
	<hr/>
Pretax profit	10,667
Income taxes (25%)	2,667
	<hr/>
After-tax profit	<u>8,000</u>

For the outlet to achieve an after-tax profit of 8,000, revenues need to increase by 33% [(53,334 - 40,000) ÷ 40,000] over last month.

Holger presents this information to the owner and argues that sales will increase to 53,334 because the weather will be hotter next month. However, the owner thinks that Holger may be worried about being replaced, and so his revenue estimates are probably biased upwards. The owner decides to investigate Holger's estimates further by comparing his revenues and costs to those in the other outlets.

GUIDE YOUR LEARNING 3.2 The Spotted Cow Creamery (Part 1)

The Spotted Cow Creamery (Part 1) illustrates a multiple-product CVP analysis with income taxes. For this illustration:

Define It	Identify Problem and Information	Identify Uncertainties	Explore Assumptions	Explore Biases
Which definitions, analysis techniques, and computations were used?	What decisions were being addressed? What information was relevant to the decisions?	What types of uncertainties were there? Consider uncertainties about: <ul style="list-style-type: none"> • Revenue and cost estimates • Interpreting results • Relevant range of operations • Feasibility of activity level 	Reread the first part of this chapter and identify the assumptions used in developing the CVP formulas. How reasonable are these assumptions for The Spotted Cow Creamery?	Why and how might the manager's bias influence the computations? Why would the owner be uncertain whether the manager had created biased revenue or cost estimates?

PERFORMING CVP ANALYSES WITH A SPREADSHEET

Q3 How are CVP calculations performed for multiple products?

Spreadsheets are often used for CVP computations, particularly when an organization has multiple products. Spreadsheets simplify the basic computations and can be designed to show how changes in volumes, selling prices, costs, or sales mix alter the results.

■ CVP Calculations for a Sales Mix

Although The Spotted Cow Creamery sells multiple products, the CVP analysis performed by the store manager did not provide computations for individual products. Instead, the analysis focused on the total amount of revenue needed to achieve a target profit. If the manager wants to use CVP results to plan future operations for individual products, the required revenue for each product needs to be determined. Such computations are performed using the sales mix. The sales mix should be stated as a proportion of units when performing CVP computations in units, and it should be stated as a proportion of revenues when performing CVP computations in revenues. Sales mix computations can become cumbersome if performed manually; it is easiest to use a spreadsheet.

To demonstrate CVP computations using a spreadsheet, suppose that Magik Bicycles developed three different products, a small bike for children and youths, a road bike, and a mountain bike. Total fixed costs for the company are \$14,700,000. Forecasted sales volumes are as follows. The sales mix in percentages is calculated from these volumes.

	Youth	Road	Mountain	Total
Forecasted volume (units)	10,000	18,000	12,000	40,000
Expected sales mix in units	25%	45%	30%	100%

Because of increased competition and an economic downturn, the managers of Magik Bicycles are uncertain about the company's ability to achieve the forecasted level of sales. They would like to know the minimum amount of sales needed for an after-tax profit of \$100,000. The company's income tax rate is 30%. The expected unit selling prices, variable costs, and contribution margins for each product are as follows:

	Youth	Road	Mountain
Price per unit	\$200	\$700	\$800
Variable cost per unit	<u>75</u>	<u>250</u>	<u>300</u>
Contribution margin per unit	<u>\$125</u>	<u>\$450</u>	<u>\$500</u>

Exhibit 3.2 shows a sample CVP spreadsheet for Magik Bicycles. Notice that all of the input data is placed in an area labeled as "Input section" in the spreadsheet. The calculations are performed outside of this area (formulas for this spreadsheet are shown in Appendix 3A). Spreadsheets designed this way allow users to alter the assumptions in the input section without performing any additional programming.

The spreadsheet in Exhibit 3.2 first uses the input data to compute expected revenues, costs, and income. The revenues and variable costs for each product are computed by multiplying the expected sales volume times the selling price and variable cost per unit shown in the input area. The revenues and variable costs for the three products are then combined to determine total revenues and total variable costs for the company. After subtracting expected fixed costs and income taxes (30% of pretax income), the expected after-tax income is \$455,000.

When an organization produces and sells a number of different products or services, we use the weighted average contribution margin per unit to determine the breakeven point or target profit in units. Similarly, we use the weighted average contribution margin ratio to determine the breakeven point or target profit in revenues. "Weighted average" here refers to the expected sales mix: 10,000 youth bikes or \$2,000,000 in revenues, 18,000 road bikes or

CURRENT PRACTICE

Spreadsheet skills are important professionally. The [American Institute of Certified Public Accountants \(AICPA\)](#) states that an entry-level accountant should be able to "appropriately use electronic spreadsheets and other software to build models and simulations."³

³This skill is an element of the competency "Leverage Technology to Develop and Enhance Functional Competencies," *AICPA Core Competency Framework*, accessed through the Library at eca.aicpaservices.org/.

EXHIBIT 3.2
Spreadsheet for Magik
Bicycles CVP with
Multiple Products

	A	B	C	D	E
1					
2	Input section	Youth Bikes	Road Bikes	Mtn. Bikes	
3	Expected sales volume-units	10,000	18,000	12,000	
4	Price per unit	\$200	\$700	\$800	
5	Variable cost per unit	\$75	\$250	\$300	
6					
7	Fixed costs	\$14,700,000			
8	Desired after-tax profit	\$100,000	(enter zero for breakeven)		
9	Income tax rate	30%			
10					
11					
12	Contribution Margin	Youth Bikes	Road Bikes	Mtn. Bikes	Total Bikes
13	Units	10,000	18,000	12,000	40,000
14	Revenue	\$2,000,000	\$12,600,000	\$9,600,000	\$24,200,000
15	Variable costs	750,000	4,500,000	3,600,000	8,850,000
16	Contribution margin	<u>\$1,250,000</u>	<u>\$8,100,000</u>	<u>\$6,000,000</u>	<u>\$15,350,000</u>
17					
18	Contrib. margin per unit	<u>\$125.00</u>	<u>\$450.00</u>	<u>\$500.00</u>	<u>\$383.75</u>
19	Contrib. margin ratio	<u>62.50%</u>	<u>64.29%</u>	<u>62.50%</u>	<u>63.43%</u>
20					
21	Expected sales mix in units	25.00%	45.00%	30.00%	100.00%
22	Expected sales mix in revenues	8.26%	52.07%	39.67%	100.00%
23					
24	Expected Income				
25	Contribution margin (above)				\$15,350,000
26	Fixed costs				14,700,000
27	Pretax income				650,000
28	Income taxes				195,000
29	After-tax income				<u>\$455,000</u>
30					
31	Preliminary CVP Calculations				
32	Target pretax profit for CVP analysis				\$142,857
33	Fixed costs plus target pretax profit				\$14,842,857
34					
35	CVP analysis in units	Youth Bikes	Road Bikes	Mtn. Bikes	Total Bikes
36	CVP calculation in units	9,669.614	17,405.305	11,603.537	38,678
37	Revenue	\$1,933,923	\$12,183,713	\$9,282,829	\$23,400,465
38	Variable costs	725,221	4,351,326	3,481,061	8,557,608
39	Contribution margin	<u>\$1,208,702</u>	<u>\$7,832,387</u>	<u>\$5,801,768</u>	14,842,857
40	Fixed costs				14,700,000
41	Pretax income				142,857
42	Income taxes				42,857
43	After-tax income				<u>\$100,000</u>
44					
45	CVP analysis in revenues	Youth Bikes	Road Bikes	Mtn. Bikes	Total Bikes
46	CVP calculation in revenues	\$1,933,923	\$12,183,713	\$9,282,829	\$23,400,465
47	Variable costs	725,221	4,351,326	3,481,061	8,557,608
48	Contribution margin	<u>\$1,208,702</u>	<u>\$7,832,387</u>	<u>\$5,801,768</u>	14,842,857
49	Fixed costs				14,700,000
50	Pretax income				142,857
51	Income taxes				42,857
52	After-tax income				<u>\$100,000</u>

Note: Appendix 3A provides a version of this spreadsheet showing the cell formulas.

\$12,600,000 in revenues, and 12,000 mountain bikes or \$9,600,000 in revenues. Given the sales mix, the weighted average contribution margin per unit is calculated as the combined contribution margin (\$15,350,000) divided by the total number of units expected to be sold (40,000), or \$383.75 per unit as computed in Exhibit 3.2.⁴ The weighted average contribution margin ratio is the combined contribution margin (\$15,350,000) divided by combined revenue (\$24,200,000), or 63.43%.⁵

⁴Another way to compute the weighted average contribution margin per unit is to sum the contribution margins for the three products, weighted by number of units sold as follows: $(10,000 \div 40,000)(\$200 - \$75) + (18,000 \div 40,000)(\$700 - \$250) + (12,000 \div 40,000)(\$800 - \$300) = \383.75 .

⁵Another way to compute the weighted average contribution margin ratio is to sum the contribution margin ratios for the three products, weighted by revenues as follows: $(\$2,000,000 \div \$24,200,000)[(\$200 - \$75) \div \$200] + [(\$12,600,000 \div \$24,200,000)][(\$700 - \$250) \div \$700] + [(\$9,600,000 \div \$24,200,000)][(\$800 - \$300) \div \$800] = 63.43\%$.

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The spreadsheet in Exhibit 3.2 performs CVP computations using both units and revenues. To achieve an after-tax target profit of 100,000, the company must earn a pretax profit of \$142,857 [$\$100,000 \div (1 - 0.30)$]. To compute the total number of units (bikes) that must be sold to achieve the target profit, we divide the fixed costs plus the target profit by the weighted average contribution margin per unit:

$$\text{Units needed for target profit} = Q = \frac{F + \text{Profit}}{(P - V)} = \frac{\$14,700,000 + \$142,857}{\$383.75 \text{ per unit}} = 38,678 \text{ units}$$

Magik needs to sell 38,678 units to achieve an after-tax target profit of \$100,000. To determine the number of units for each product that must be sold, we multiply the total number of units (38,678) by each product's expected sales mix in units. For example, the company must sell 38,678 units \times (10,000 units \div 40,000 units), or 9,670 youth bikes.

To calculate the amount of revenue needed to achieve the target after-tax profit of \$100,000, we divide the fixed costs plus the target pretax profit by the weighted average contribution margin ratio:

$$\text{Revenues} = \frac{F + \text{Profit}}{\text{CMR}} = \frac{\$14,700,000 + \$142,857}{63.43\%} = \$23,400,373$$

The difference between the spreadsheet and this hand-calculated amount is due to rounding, as are any differences in the following amounts. To determine the revenues for each product that must be sold, we multiply the total revenues (\$23,400,373) by each product's expected sales mix in revenues. For example, the company must achieve $\$23,400,373 \times (\$2,000,000 \div \$24,200,000)$, or \$1,933,914 in revenues from youth bikes. Notice that the required revenue for each product is equal to the required number of units times the expected selling price. For youth bikes, 9,670 units \times \$200 per unit = \$1,934,000.

The results of calculations using units and revenues are always identical. Because information in the example was given in units, it would have been easiest to create the spreadsheet using only the computations for CVP in units. However, in some situations per-unit information is not available. In those cases, it is necessary to perform CVP calculations using revenues. Later in the chapter we revisit the ice cream shop illustration to analyze the influence of sales mix on the total contribution margin.

■ CVP Sensitivity Analysis

One of the benefits of creating a spreadsheet with a separate input section is that additional CVP analyses can easily be performed by the changing input data. For example, suppose the managers of Magik Bicycles want to know the number of bikes they must sell to break even. We can return to the spreadsheet in Exhibit 3.2 and change the "Desired after-tax profit" to zero. The resulting spreadsheet, showing only CVP calculations in units, is presented in Exhibit 3.3.

The managers of Magik Bicycles could use the CVP spreadsheet to perform several different types of sensitivity analyses. Suppose sales of the mountain bike are falling behind

Q5 What assumptions and limitations should managers consider when using CVP analysis?

EXHIBIT 3.3
Spreadsheet Results for
Magik Bicycles Breakeven
Analysis

	A	B	C	D	E
31	Preliminary CVP Calculations				
32	Target pretax profit for CVP analysis				\$0
33	Fixed costs plus target pretax profit				\$14,700,000
34					
35	CVP analysis in units	Youth Bikes	Road Bikes	Mtn. Bikes	Total Bikes
36	CVP calculation in units	9,576.547	17,237.785	11,491.857	38,306
37	Revenue	\$1,915,309	\$12,066,450	\$9,193,485	\$23,175,244
38	Variable costs	718,241	4,309,446	3,447,557	8,475,244
39	Contribution margin	\$1,197,068	\$7,757,003	\$5,745,928	14,700,000
40	Fixed costs				14,700,000
41	Pretax income				0
42	Income taxes				0
43	After-tax income				\$0

expectations. They could determine the effects of the change in sales mix on results. Every assumption in the data input box is easily changed to update information. Sensitivity analysis helps managers explore the potential impact of variations in data they consider to be particularly important or uncertain.

Discretionary Expenditure Decision

Q1 What is cost-volume-profit (CVP) analysis, and how is it used for decision making?

CVP analysis also helps managers make business decisions such as whether to increase or decrease discretionary expenditures. For example, suppose the managers of Magik Bicycles want to advertise one of their products more heavily. A distributor pointed out that the road bike price was less than a competitor's price for a model with fewer features. The competitor's brand name is quite well known, but the distributor thinks that he could sell at least 10% more road bikes if Magik launched a regional advertising campaign.

The managers of Magik estimate that an additional expenditure of \$100,000 in advertising will increase road bike sales by 5%, to 18,900 bikes. To estimate the effects of the proposed expenditure, we return to the spreadsheet in Exhibit 3.2 and make two changes. First, fixed costs would increase by \$100,000 to \$14,800,000. Second, the expected volume of road bikes sold would increase to 18,900. The resulting spreadsheet in Exhibit 3.4 indicates that after-tax profits are expected to increase by \$213,500 from \$455,000 to \$668,500. Notice on the spreadsheet that the change in sales mix affects the weighted average contribution margin; it changes from 383.75 to \$385.21.

We could perform the same calculation without the spreadsheet by subtracting the \$100,000 investment in fixed costs from the additional contribution margin of \$405,000 [900 bikes × (\$700 – \$250)]. The resulting incremental after-tax profit is \$213,500 [(\$405,000 – \$100,000)(1 – 0.30)]. Because profits are expected to increase more than costs for this advertising campaign, the managers would be likely to make the additional investment.

CHAPTER REFERENCE

Chapter 4 uses CVP analysis for additional types of decisions. We also learn that decisions are often influenced by qualitative information that is not valued in numerical terms.

Planning, Monitoring, and Motivating with CVP

CVP analyses are useful for planning and monitoring operations and for motivating employee performance. If the owner of The Spotted Cow Creamery obtains similar information for the other outlets, results can be compared to identify differences in revenue levels and cost functions. For example, unusually high labor costs might suggest that the low-profit outlet is overstaffed or inefficient. Once the owner analyzes the reasons for differences in profitability, emphasis can be placed on increasing revenues, reducing costs, or both. The owner can also hold managers more accountable for performance, which should motivate their work efforts toward the owner's goals.

CHAPTER REFERENCE

In Chapter 10, CVP analysis is used to create flexible budgets for measuring and monitoring performance at different levels of activity.

EXHIBIT 3.4
Spreadsheet for Magik Bicycles Advertising Expenditure Decision

	A	B	C	D	E
12	Contribution Margin	Youth Bikes	Road Bikes	Mtn. Bikes	Total Bikes
13	Units	10,000	18,900	12,000	40,900
14	Revenue	\$2,000,000	\$13,230,000	\$9,600,000	\$24,830,000
15	Variable costs	750,000	4,725,000	3,600,000	9,075,000
16	Contribution margin	<u>\$1,250,000</u>	<u>\$8,505,000</u>	<u>\$6,000,000</u>	<u>\$15,755,000</u>
17					
18	Contrib. margin per unit	<u>\$125.00</u>	<u>\$450.00</u>	<u>\$500.00</u>	<u>\$385.21</u>
19	Contrib. margin ratio	<u>62.50%</u>	<u>64.29%</u>	<u>62.50%</u>	<u>63.45%</u>
20					
21	Expected sales mix in units	24.45%	46.21%	29.34%	100.00%
22	Expected sales mix in revenues	8.05%	53.28%	38.66%	100.00%
23					
24	Expected Income				
25	Contribution margin (above)				\$15,755,000
26	Fixed costs				14,800,000
27	Pretax income				955,000
28	Income taxes				286,500
29	After-tax income				<u>\$668,500</u>

DIE GEFLECKTE KUH EIS (THE SPOTTED COW CREAMERY) (PART 2)
THE INFLUENCE OF SALES MIX ON PROFITABILITY



The owner of The Spotted Cow Creamery has several profitable stores. He asked the store managers to provide information about their sales mix, specifically the amount of beverage versus ice cream products sold. Beverages provide a much larger contribution margin than ice cream. After analyzing the data, he found that about half of the revenues in the most profitable stores were for the sale of beverages. In addition, these stores have more stable sales throughout the winter because they sell specialty coffee beverages as well as soft drinks.

The owner shared this information with Holger, the manager of a less profitable store. Holger investigates the contribution margins from beverages and ice cream at his store. He sets up a spreadsheet to examine the influence of the sales mix on profitability, shown in Exhibit 3.5(a). He finds that beverages are about 15% of total revenue (6,000 ÷ 40,000). The contribution margin ratio for beverages is 93% (5,600 ÷ 6,000), whereas the contribution margin for ice cream is 42% (14,400 ÷ 34,000). When he changes the desired sales mix in the spreadsheet from 15% to 50% beverages to match the sales mix of more profitable stores, the after-tax income increases by a sizeable amount from 3,000 to 8,353 as indicated in Exhibit 3.5(b).

Holger realizes that several strategies would increase the percentage of beverages in his current sales mix. First, he could require the sales clerks to suggest a beverage with each sale. In addition, he could emphasize beverages in his advertising. He could also analyze his competitors' beverage prices to be certain that his prices are competitive. A small drop in the price of beverages might increase the volume of beverages sold more than enough to offset the decline in contribution margin ratio. He uses the spreadsheet to perform sensitivity analysis around these factors.

EXHIBIT 3.5 Spreadsheet for The Spotted Cow Creamery

	A	B	C	D
1				
2	Input section			
3		Beverage	Ice Cream	Total
4	Revenue	€6,000	€34,000	€40,000
5	Variable cost	400	19,600	20,000
6	Current sales mix in revenues	15%	85%	100%
7	Fixed costs			16,000
8	Tax rate			25%
9	Desired sales mix in revenues	15%	85%	100%
10				
11				Weighted Average
12	Contribution margin ratio	93%	42%	50%
13				
14	Income statement			
15	Revenue	€6,000	€34,000	€40,000
16	Variable cost	400	19,600	20,000
17	Contribution margin	5,600	14,400	20,000
18				
19	Fixed costs			16,000
20	Pretax income			4,000
21	Taxes			1,000
22	After tax income			€3,000

(a) Current Sales Mix

	A	B	C	D
1				
2	Input section			
3		Beverage	Ice Cream	Total
4	Revenue	€6,000	€34,000	€40,000
5	Variable cost	400	19,600	20,000
6	Current sales mix in revenues	15%	85%	100%
7	Fixed costs			16,000
8	Tax rate			25%
9	Desired sales mix in revenues	50%	50%	100%
10				
11				Weighted Average
12	Contribution margin ratio	93%	42%	68%
13				
14	Income statement			
15	Revenue	€20,000	€20,000	€40,000
16	Variable cost	1,333	11,529	12,863
17	Contribution margin	18,667	8,471	27,137
18				
19	Fixed costs			16,000
20	Pretax income			11,137
21	Taxes			2,784
22	After tax income			€8,353

(b) Desired Sales Mix

GUIDE YOUR LEARNING 3.3 The Spotted Cow Creamery (Part 2)

The Spotted Cow Creamery (Part 2) illustrates the influence of sales mix on profitability. For this illustration:

Compute It	Identify Uncertainties	Explore Uses
For Exhibit 3.5, manually recalculate: <ul style="list-style-type: none"> • Sales mix in units • Sales mix in revenues • Weighted average contribution margin ratio 	At the end of the illustration, the store manager was considering several strategies for changing his store's sales mix. What uncertainties does the manager face?	How was CVP information used by the owner? How was it used by the manager?

ASSUMPTIONS AND LIMITATIONS OF COST-VOLUME-PROFIT ANALYSIS

Q5 What assumptions and limitations should managers consider when using CVP analysis?

CHAPTER REFERENCE

Chapter 2 explains the importance of the relevant range in measuring the cost function.

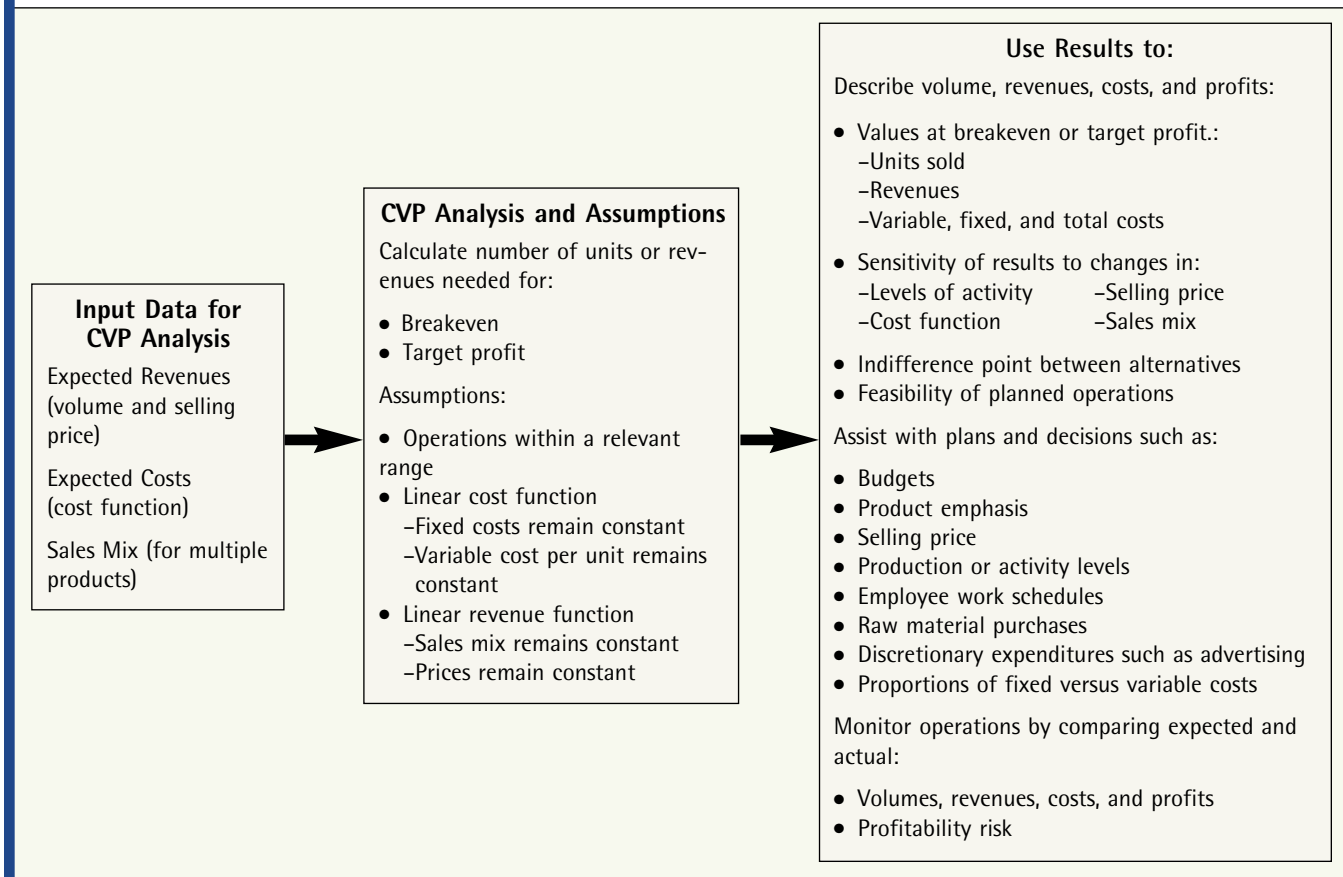
Exhibit 3.6 summarizes the input data, assumptions, and uses of CVP analysis. CVP analysis relies on several assumptions. In Chapter 2 we assumed for the linear cost function ($F + V \times Q$) that production volumes are within a relevant range of operations where fixed costs remain fixed and variable costs remain constant. In addition, for CVP analysis, we assume that selling prices remain constant and that the sales mix is constant. Sensitivity analysis can be performed to determine the sensitivity of profits to these assumptions.

■ Uncertainties and Quality of Input Data

As indicated in Exhibit 3.6, CVP analysis relies on forecasts of expected revenues and costs. CVP assumptions rule out fluctuations in revenues or costs that might be caused by common business factors such as supplier volume discounts, learning curves, changes in production efficiency, or special customer discounts. In addition, many uncertainties may arise about whether CVP assumptions will be violated, such as the following:

- Can volume of operating activity be achieved?
- Will selling prices increase or decrease?
- Will sales mix remain constant?
- Will fixed or variable costs change as operations move into a new relevant range?
- Will costs change due to unforeseen causes?
- Are revenue and cost estimates biased?

EXHIBIT 3.6 Input Data, Assumptions, and Uses of CVP Analysis



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EXHIBIT 3.7 Examples of Business Uncertainties

Ashanti Goldfields Company Ltd.	Bank of Montreal	Coca-Cola FEMSA, S.A. de C.V.	eBay, Inc.	Nokia Corporation	Sony Corporation
Ghana	Canada	Mexico	United States	Finland	Japan
Gold mining and exploration	Credit and non-credit banking services	Production and distribution of Coca-Cola products	Web-based marketplace and payment services	Mobile communications	Electronic equipment design and manufacturing
<ul style="list-style-type: none"> • Gold prices • Anticipated life of mines • Power supply • Labor relations 	<ul style="list-style-type: none"> • Changes in global capital markets • Interest rates • Regulatory changes • Technological changes 	<ul style="list-style-type: none"> • Deterioration in relationships with the Coca-Cola Company • Governmental price controls • More stringent environmental regulations • High inflation 	<ul style="list-style-type: none"> • Retaining active user base • Consumer confidence in Web site security • Management of fraud loss • Retaining key employees 	<ul style="list-style-type: none"> • Global network reliance on large multiyear contracts • Failure of product quality • System or network disruptions • Electromagnetic field-related litigation 	<ul style="list-style-type: none"> • Levels of consumer spending • Speed and nature of technology change • Change in consumer preferences • Ability to reduce workforce
Examples adapted from "Forward-Looking Information" in Form 20-F (filed with the SEC).	Examples adapted from "Caution Regarding Forward-Looking Statements" under "Investor Relations" at www4.bmo.com .	Examples adapted from "Cautionary Statements" in presentation to J.P. Morgan, July 2003	Examples adapted from "Risk Factors That May Affect Results of Operations and Financial Condition" in 2002 annual report.	Examples adapted from "Risk Factors" in 2002 annual report.	Examples adapted from "Cautionary Statement" under Investor Relations at www.sony.net/index.html .

CHAPTER REFERENCE

We address the quality of expected revenue and cost information further in Chapter 10 (budgeting).

All organizations are subject to uncertainties, leading to risk that they will fail to meet expectations. Exhibit 3.7 summarizes major business uncertainties for six companies in a variety of industries around the world. Even though each organization is subject to unique business risks, all face uncertainties related to the economic environment. Some organizations are subject to more uncertainty than others. For example, uncertainties are greater in industries experiencing rapid technological and market change or intense competition.

■ Quality of CVP Technique

To help managers make better decisions, accountants evaluate the quality of the techniques they use, given the organizational setting and decisions to be made. This evaluation helps determine when techniques such as CVP analysis are likely to be an appropriate tool and how much reliance to place on the results. The quality of information generated from an analysis technique is higher if the economic setting is consistent with the technique's underlying assumptions.

Strict CVP assumptions are violated in many business settings. The types of uncertainties already discussed can lead to nonlinear behavior in revenues and costs. In addition, it may be difficult to determine the point of operating activity where operations move into a new relevant range.

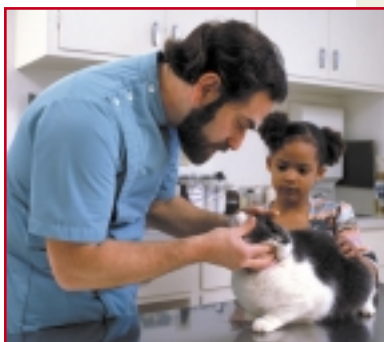
Nevertheless, in many business settings CVP analysis provides useful information. Accountants and managers use their knowledge of the organization's operations and their judgment to evaluate whether the CVP assumptions are reasonable for their setting. They can rely more on CVP results when the assumptions are less likely to be violated. Also, the data used in CVP calculations must be updated continually to be useful.

■ CVP for Nonprofit Organizations

The basic CVP formulas in this chapter are written for typical for-profit businesses such as manufacturers, retailers, or service providers. Nonprofit organizations often receive grants and donations. These revenue sources complicate CVP calculations because they could be affected by quantity of goods or services sold. Grants and donations that are unrelated to the

quantity of goods or services sold are offset against fixed costs in the CVP formulas. However, when grants and donations vary with a not-for-profit organization's operating activities, they might be included in revenues or subtracted from variable costs. The treatment depends on the nature of the grant or donation.

The following illustration continues the story of Small Animal Clinic from Chapter 2. Recall that Small Animal Clinic is a not-for-profit organization that treats small animals. It received a foundation grant that matches incoming revenues. For example, if a pet owner pays \$30 in fees, the foundation matches with an additional \$30 to the clinic. In this case, the grant is included in revenues for CVP calculations.



SMALL ANIMAL CLINIC

NOT-FOR-PROFIT ORGANIZATION CVP ANALYSIS WITH TWO RELEVANT RANGES

Leticia Brown, Small Animal Clinic manager, and the accountant, Josh Hardy, are completing the operating budget for 2006. Leticia estimated that the clinic will experience 3,800 animal visits, and Josh estimated the cost function as follows:⁶

$$TC = \$119,009 + \$16.40Q$$

where Q is the number of animal visits. Leticia and Josh budgeted revenue per animal visit at \$60 (\$30 in fees plus \$30 in matching grant). Thus, they estimated that the clinic should achieve a surplus of \$46,671 [(\$60)(3,800) - \$119,009 - (\$16.40)(3,800)]. The clinic is a not-for-profit organization and pays no income taxes on its surplus.

To complete the planning process for next year, Leticia asks Josh to compute the clinic's breakeven point. As manager of a not-for-profit organization, she is particularly sensitive to financial risk and wants to know how much the clinic's activity levels could drop before a loss would occur.

Breakeven Compared to Budget

Josh performs the following calculations. With revenue per visit of \$60, the contribution margin per animal visit is

$$P - V = \$60.00 - \$16.40 = \$43.60$$

Josh solves for Q with profit equal to \$0 to find the breakeven point in number of animal visits:

$$Q = \frac{F + \text{Profit}}{P - V} = \frac{(\$119,009 + \$0)}{\$43.60} = 2,730 \text{ visits}$$

Leticia is pleased to see that the budgeted number of animal visits (3,800) is significantly higher than the breakeven number. This result gives her considerable assurance that the clinic is not likely to incur a loss, even if revenues fail to achieve targeted levels or if costs exceed estimated amounts.

Potential Investment in New Equipment

During the first two months of 2006, Leticia learns that the number of animal visits at Small Animal Clinic is running approximately 10% higher than the budget, and costs seem to be under control. Leticia thinks that the clinic might be on track for a high surplus this year.

For the past two years, Leticia has been interested in purchasing equipment costing \$200,000 to provide low-cost neutering services. This year PAWS, a local charity, offered to pay for half of the equipment cost, but only after the clinic raises the other half of the funds. Currently the clinic has no excess cash because surpluses from prior years were invested in other projects. Thus, the
(continued)

⁶In the Chapter 2 illustration Small Animal Clinic (Part 2), the cost function was calculated as: $TC = \$119,009 + (\$15.20)(\text{Number of animal visits}) + (0.04)(\text{Fee revenue})$. If average fee revenue is \$30 per animal visit, then the last term in the cost function can be rewritten as $(0.04)(\$30)(\text{Number of animal visits})$, which can be simplified as $(\$1.20)(\text{Number of animal visits})$. This substitution allows the cost function to be rewritten as: $TC = \$119,009 + (\$16.40)(\text{Number of animal visits})$. This version of the cost function is appropriate for estimating total costs for the clinic, but it would not be appropriate for estimating total costs for a single animal visit, where the fees vary depending on the services performed.

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clinic needs to raise \$100,000 to receive the PAWS grant. Leticia asks Josh to calculate the number of animal visits needed to achieve a surplus of \$100,000.

Calculating and Analyzing Targeted Activity Level

Josh calculates the expected quantity needed to achieve \$100,000 surplus as follows:

$$Q = \frac{F + \text{Profit}}{P - V} = \frac{\$119,009 + \$100,000}{\$60.00 - \$16.40} = \frac{\$219,009}{\$43.60} = 5,024 \text{ animal visits}$$

He then calculates the total dollar amount of revenue needed:

$$\text{Revenues} = \frac{F + \text{Profit}}{(P - V)/P} = \frac{\$119,009 + \$100,000}{\$43.60/\$60.00} = \$310,389$$

Josh tells Leticia that the clinic will need to earn \$301,389 in revenues or 5,024 visits to achieve a surplus of \$100,000.

The budgeted level of activity (3,800 animal visits) is substantially higher than the level of activity needed to break even (2,730 animal visits). If animal visits continue to exceed this year's budget by 10%, Josh estimates that animal visits will reach 4,180 (3,800 × 1.10) by year-end. However, he thinks that it would be very difficult to achieve a targeted surplus of \$100,000 (5,024 animal visits).

CVP Adjusted for Change in Relevant Range

As Josh works on his report, he realizes that the clinic's cost function might change if the number of animal visits gets very high. Leticia told him that she will probably hire another technician and need to rent more space and purchase additional equipment if animal visits exceed 4,000 this year. Therefore, Josh's cost function for 5,024 visits is wrong. He develops a new cost function assuming that an additional technician, space, and equipment will increase fixed costs by about \$60,000 per year.

$$TC = (\$119,009 + \$60,000) + \$16.40Q = \$179,009 + \$16.40Q, \text{ for } Q > 4,000$$

Thus, Josh's earlier CVP analysis was incorrect when animal visits exceed 4,000. The level of activity needed for a targeted surplus of \$100,000 needs to be recalculated:

$$(\$179,009 + \$100,000) \div \$43.60 = 6,400 \text{ for } Q > 4,000$$

Josh notices that an activity level of 6,400 animal visits is noticeably higher than the 5,024 visits he first calculated. He realizes how important it is to adjust for the relevant range when performing CVP analyses.

When Josh shows Leticia the new results, they agree that the clinic cannot raise the funds for new equipment by increasing the number of visits to 6,400. Leticia may need to cut costs or seek other ways to pay for the neutering equipment. The additional fixed cost would also require the clinic to have a much higher volume of operations to avoid a loss.

GUIDE YOUR LEARNING 3.4 Small Animal Clinic

Small Animal Clinic illustrates a CVP analysis with target profit and two relevant ranges for a not-for-profit organization. For this illustration:

Define It	Identify Problem and Information	Identify Uncertainties	Explore Assumptions
Describe how the CVP computations change when more than one relevant range is involved.	What decisions were being addressed? Why was CVP information useful for the decisions?	What were the uncertainties? Consider uncertainties about: <ul style="list-style-type: none"> • Revenue and cost estimates • Interpreting results • Relevant range of operations • Feasibility of activity level 	How reasonable are the CVP assumptions for Small Animal Clinic?

MARGIN OF SAFETY AND DEGREE OF OPERATING LEVERAGE

In Small Animal Clinic, the manager used CVP information to help her learn how much the volume of business could decline before the clinic would incur a loss. The manager of Spotted Cow Creamery was able to identify the specific products to emphasize for increased profitability. Managers are often interested in these types of questions. In addition, information from CVP analysis can be used to help manage operational risk.

Q6 How are margin of safety and operating leverage used to assess operational risk?

Margin of Safety

The **margin of safety** is the excess of an organization's expected future sales (in either revenue or units) above the breakeven point. The margin of safety indicates the amount by which sales could drop before profits reach the breakeven point:

$$\begin{aligned} \text{Margin of safety in units} &= \text{Actual or estimated units of activity} - \text{Units at breakeven point} \\ \text{Margin of safety in revenues} &= \text{Actual or estimated revenue} - \text{Revenue at breakeven point} \end{aligned}$$

The margin of safety is computed using actual or estimated sales values, depending on the purpose. To evaluate future risk when planning, use estimated sales. To evaluate actual risk when monitoring operations, use actual sales. If the margin of safety is small, managers may put more emphasis on reducing costs and increasing sales to avoid potential losses. A larger margin of safety gives managers greater confidence in making plans such as incurring additional fixed costs.

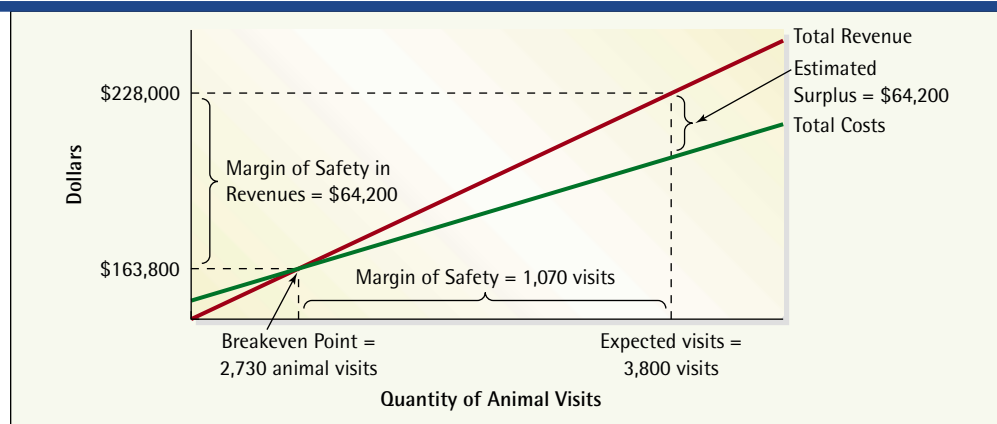
The **margin of safety percentage** is the margin of safety divided by actual or estimated sales, in either units or revenues. This percentage indicates the extent to which sales can decline before profits become zero.

$$\text{Margin of safety percentage in units} = \frac{\text{Margin of safety in units}}{\text{Actual or estimated units}}$$

$$\text{Margin of safety percentage in revenues} = \frac{\text{Margin of safety in revenue}}{\text{Actual or estimated revenue}}$$

When the original budget was created for Small Animal Clinic, the breakeven point was calculated as 2,730 animal visits, or \$163,800 in revenues. However, Leticia and Josh expected 3,800 animal visits, for \$228,000 in revenue. Their margin of safety in units of animal visits was 1,070 (3,800 - 2,730) and in revenues was \$64,200 (\$228,000 - \$163,800). Their margin of safety percentage was 28.2% (1,070 ÷ 3,800, or \$64,200 ÷ \$228,000). In other words, their sales volume could drop 28.2% from expected levels before they expected to incur a loss. Exhibit 3.8 provides a CVP graph for this information.

EXHIBIT 3.8
CVP Graph and Margin of Safety for Small Animal Clinic



■ Degree of Operating Leverage

Managers decide how to structure the cost function for their organizations. Often, potential trade-offs are made between fixed and variable costs. For example, a company could purchase a vehicle (a fixed cost) or it could lease a vehicle under a contract that charges a rate per mile driven (a variable cost). Exhibit 3.9 lists some of the common advantages and disadvantages of fixed costs. One of the major disadvantages of fixed costs is that they may be difficult to reduce quickly if activity levels fail to meet expectations, thereby increasing the organization's risk of incurring losses.

The **degree of operating leverage** is the extent to which the cost function is made up of fixed costs. Organizations with high operating leverage incur more risk of loss when sales decline. Conversely, when operating leverage is high an increase in sales (once fixed costs are covered) contributes quickly to profit. The formula for operating leverage can be written in terms of either contribution margin or fixed costs, as shown here.⁷

$$\text{Degree of operating leverage in terms of contribution margin} = \frac{\text{Contribution margin}}{\text{Profit}} = \frac{\text{TR} - \text{TVC}}{\text{Profit}} = \frac{(P - V) \times Q}{\text{Profit}}$$

$$\text{Degree of operating leverage in terms of fixed costs} = \frac{F}{\text{Profit}} + 1$$

Managers use the degree of operating leverage to gauge the risk associated with their cost function and to explicitly calculate the sensitivity of profits to changes in sales (units or revenues):

$$\% \text{ change in profit} = \% \text{ change in sales} \times \text{Degree of operating leverage}$$

For Small Animal Clinic, the variable cost per animal visit was \$16.40 and the fixed costs were \$119,009. With budgeted animal visits of 3,800, the managers expected to earn a profit of \$46,671. The expected degree of operating leverage using the contribution margin formula is then calculated as follows:

$$\text{Degree of operating leverage} = \frac{(\$60 - \$16.40) \times 3,800 \text{ visits}}{\$46,671} = \frac{\$165,680}{\$46,671} = 3.55$$

We arrive at the same answer of 3.55 if we use the fixed cost formula:

$$\text{Degree of operating leverage} = \frac{\$119,009}{\$46,671} + 1 = 2.55 + 1 = 3.55$$

EXHIBIT 3.9 Advantages and Disadvantages of Fixed Costs

Common Advantages	Common Disadvantages
<ul style="list-style-type: none"> • Fixed costs might cost less in total than variable costs. • Companies might require unique assets (e.g., expert labor or specialized production facilities) that must be acquired through long-term commitments. • Fixed assets such as automation and robotics equipment can significantly improve operating efficiency. • Fixed costs are easier to plan; they do not fluctuate with levels of activity. 	<ul style="list-style-type: none"> • Investing in fixed resources might divert management attention away from the organization's core competencies. • Fixed costs typically require a longer financial commitment; it can be difficult to reduce them quickly. • Underinvestment or overinvestment in fixed costs could affect profits and may not easily be changed in the short term.

⁷To see the relationship between the two formulas, recall the profit equation: Profit = (P - V) × Q - F, which can be rewritten as F + Profit = Contribution margin. In turn, Degree of operating leverage = Contribution margin ÷ Profit = (F + Profit) ÷ Profit = (F ÷ Profit) + 1.

The degree of operating leverage and margin of safety percentage are reciprocals.

$$\text{Margin of safety percentage} = \frac{1}{\text{Degree of operating leverage}}$$

$$\text{Degree of operating leverage} = \frac{1}{\text{Margin of safety percentage}}$$

If the margin of safety percentage is small, then the degree of operating leverage is large. In addition, the margin of safety percentage is smaller as the fixed cost portion of total cost gets larger. As the level of operating activity increases above the breakeven point, the margin of safety increases and the degree of operating leverage decreases. For Small Animal Clinic, the reciprocal of the margin of safety percentage is 3.55 ($1 \div 0.282$). The reciprocal of the degree of operating leverage is 0.282 ($1 \div 3.55$).

■ Using the Degree of Operating Leverage to Plan and Monitor Operations

CURRENT PRACTICE

Before 1983, Medicare used cost-based payment. Hospitals had high operating leverage because risk of loss was low. After Medicare changed to a flat fee per patient, managers lowered their operating leverage.⁸

Managers need to consider the degree of operating leverage when they decide whether to incur additional fixed costs, such as purchasing new equipment or hiring new employees. They also need to consider the degree of operating leverage for potential new products and services that could increase an organization's fixed costs relative to variable costs. If additional fixed costs cause the degree of operating leverage to reach what they consider an unacceptably high level, managers often use variable costs—such as temporary labor—rather than additional fixed costs to meet their operating needs.

For example, the technicians at the Small Animal Clinic are paid a salary and work 40-hour weeks. Suppose Leticia could hire part-time technicians at \$20.00 per hour instead of hiring full-time technicians at the current salaries of \$78,009. If each visit requires about an hour of technician time, the new cost function would be $TC = (\$119,009 - \$78,009) + (\$16.40 + \$20.00)Q = \$41,000 + \$36.40Q$. The breakeven point decreases considerably to 1,738 animal visits [$\$41,000 \div (\$60.00 - \$36.40)$ per animal visit] or \$104,280. Profit at $Q = 3,800$ animal visits is \$48,680 [$\$228,000 - \$41,000 - (3,800 \text{ animal visits} \times \$36.40 \text{ per animal visit})$]. Operating leverage at 3,800 animal visits becomes 1.84 [$(\$41,000 \div \$48,680) + 1$], which is much lower than the 3.55 when technicians are a fixed cost. Although operating leverage improved, the cost for technicians increased from \$18.75 per hour [$\$78,009 \div (2 \text{ technicians} \times 2,080 \text{ hours per technician per year})$] to \$20.00 per hour.

The advantage of having technicians as hourly workers is that they can be scheduled only for hours when appointments are also scheduled. When business is slow fewer technician hours are needed, which means less risk of incurring losses if the number of visits drops. Exhibit 3.10 provides a CVP graph of the two options. Risk decreases considerably when the breakeven point is so much lower. On the other hand, it may be more difficult to hire qualified and dependable technicians unless work hours and pay can be guaranteed.

An **indifference point** is the level of activity at which equal cost or profit occurs across multiple alternatives. To provide Leticia with additional information as she considers changing the cost structure, Josh calculates the indifference point. Using the budgeted assumptions, Josh sets the two cost functions equal to each other and then solves for Q as follows:

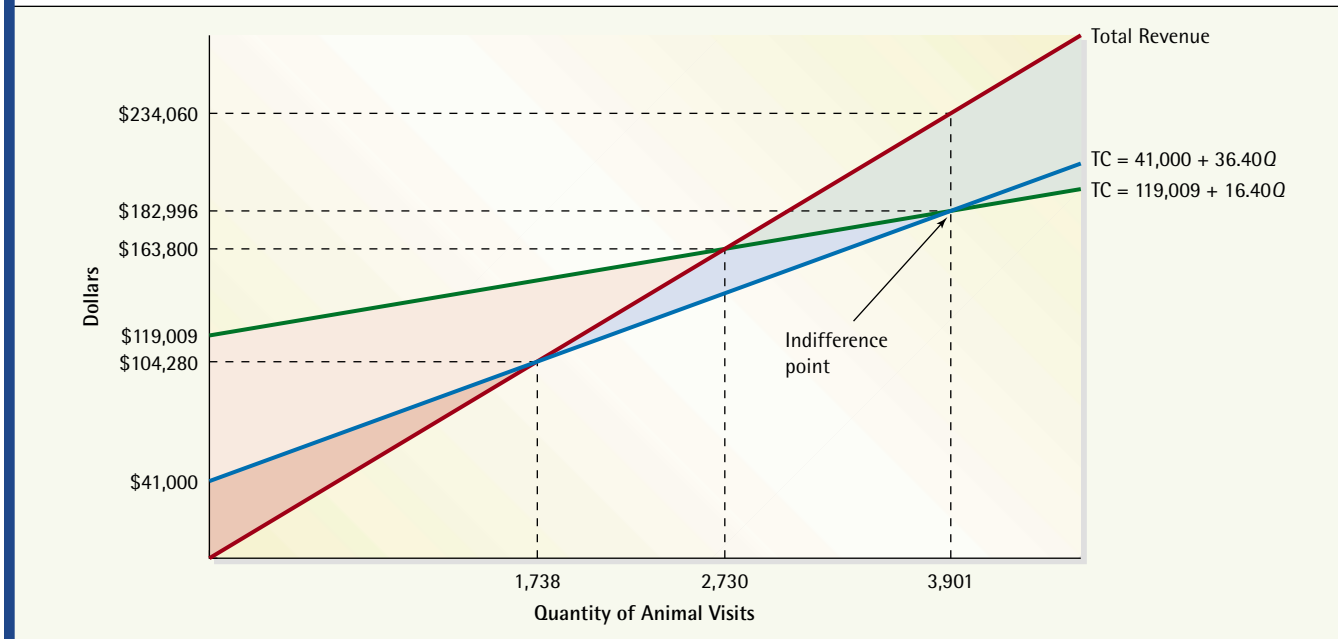
$$\begin{aligned} \$41,000 + \$36.40Q &= \$119,009 + \$16.40Q \\ \$20Q &= \$78,009, \text{ so } Q = 3,901 \end{aligned}$$

When visits are fewer than 3,901, the clinic profit will be greater using more variable cost. When visits exceed 3,901, the clinic is better off using more fixed costs, assuming that the fixed costs remain constant up to 4,000 visits. When visits exceed 4,000, we know that additional fixed costs will be incurred, and then a new indifference point will need to be calculated.

⁸S. Kallapur and L. Eldenburg, "Uncertainty, Real Options, and Cost Behavior: Evidence from Washington State Hospitals," University of Arizona Working Paper, 2003.

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EXHIBIT 3.10 CVP Graph for Small Animal Clinic with Different Degrees of Operating Leverage



Notice that the indifference point calculation ignores operational risk. At 3,901 animal visits, the clinic is expected to earn the same profit under the two cost function alternatives. However, the clinic’s operational risk is greater for the cost function having higher fixed costs. Therefore, the clinic’s manager would not necessarily be indifferent between the two cost functions if 3,901 animal visits were expected.

GUIDE YOUR LEARNING 3.5 Key Terms

Stop to confirm that you understand the new terms introduced in the last several pages:

- Margin of safety (p. 103)
- Margin of safety percentage (p. 103)
- Degree of operating leverage (p. 104)
- Indifference point (p. 105)

For each of these terms, write a definition in your own words.

FOCUS ON ETHICAL DECISION MAKING
Temporary Labor



In recent years, U.S. companies have increasingly relied on temporary labor (also called contingent or contract workers) to fill positions that in the past would have been filled by regular employees. Temporary jobs span the entire workforce including manufacturing, service, farm, and professional services. Managers gain many benefits including the following:

- Reduce risk of loss by increasing the proportion of variable costs.
- Quickly increase and decrease employment levels in response to economic changes.
- Pay higher wages to skilled workers without inflating the pay scales of regular employees.
- Pay lower wages and avoid making hiring commitments to low-skilled employees.
- Fill positions while recruiting permanent workers during labor shortages.

Many economists and business analysts argue that temporary labor is good for workers and the economy. Temporary work arrangements provide the following economic benefits:

- Reduce overall unemployment levels because employers are less reluctant to hire temporary labor than regular employees.
- Increase employment opportunities for new workforce entrants, workers laid off from jobs, and workers wanting flexible work schedules.
- Improve regular employee morale by reducing their unemployment risk.

On the other hand, labor groups, homeless advocacy groups, and others believe that temporary labor arrangements are socially harmful. They argue that the use of temporary labor contributes to the following issues:

- Unfairly reduces overall pay scales for skilled and unskilled workers.
- Increases unemployment risk for the least-skilled and lowest-paid workers, contributing to poverty and homelessness.
- Reduces worker representation as well as health care and retirement benefits.

SOURCES: J. C. Cooper and K. Madigan, "U.S.: Labor's New Flexibility Cuts Two Ways," *Business Week*, December 24, 2001; and S. N. Houseman, A. L. Kalleberg, and G. A. Erickcek, "The Role of Temporary Help Employment in Tight Labor Markets," Upjohn Institute Staff Working Paper No. 01-73, July 2001. Available at www.upjohninst.org/publications/wp/01-73.pdf.

Practice Ethical Decision Making

In Chapter 1, we learned about a process for making ethical decisions (Exhibit 1.11). You can address the following questions to improve your skills for making ethical decisions. Think about your answers to these questions and discuss them with others.

Ethical Decision-Making Process	Questions to Consider about This Ethical Dilemma
Identify ethical problems as they arise.	Does the hiring of temporary labor create an ethical problem? Why or why not?
Objectively consider the well-being of others and society when exploring alternatives.	Different viewpoints for this problem were described in the preceding example. What assumptions lie behind each viewpoint?
Clarify and apply ethical values when choosing a course of action.	Is the hiring of temporary labor a business issue, a social issue, or both? Explain. Identify the values you use to answer the following questions: <ul style="list-style-type: none"> • Is it fair for employers to pay different wage rates and provide different benefits to temporary and permanent workers who perform the same jobs? • Is it fair for businesses to pass their business risks directly on to the employees?
Work toward ongoing improvement of personal and organizational ethics.	How can company managers determine on an ongoing basis whether their hiring practices are ethical?

APPENDIX 3A

Spreadsheet Formulas for Magik Bicycles Spreadsheet

The following formulas were used for the spreadsheet shown in Exhibit 3.2.

	A	B	C	D	E
1					
2	Input section	Youth Bikes	Road Bikes	Mtn. Bikes	
3	Expected sales volume-units	10,000	18,000	12,000	
4	Price per unit	200	700	800	
5	Variable cost per unit	75	250	300	
6					
7	Fixed costs	14,700,000			
8	Desired after-tax profit	100,000	(enter zero for breakeven)		
9	Income tax rate	0.3			
10					
11					
12	Contribution Margin	Youth Bikes	Road Bikes	Mtn. Bikes	Total Bikes
13	Units	=B3	=C3	=D3	=SUM(B3:D3)
14	Revenue	=B3*B4	=C3*C4	=D3*D4	=SUM(B14:D14)
15	Variable costs	=B5*B3	=C5*C3	=D5*D3	=SUM(B15:D15)
16	Contribution margin	=B14-B15	=C14-C15	=D14-D15	=SUM(B16:D16)
17					
18	Contrib. margin per unit	=B16/B13	=C16/C13	=D16/D13	=E16/E13
19	Contrib. margin ratio	=B16/B14	=C16/C14	=D16/D14	=E16/E14
20					
21	Expected sales mix in units	=B3/\$E13	=C3/\$E13	=D3/\$E13	=SUM(B21:D21)
22	Expected sales mix in revenues	=B14/\$E14	=C14/\$E14	=D14/\$E14	=SUM(B22:D22)
23					
24	Expected Income				
25	Contribution margin (above)				=E16
26	Fixed costs				=B7
27	Pretax income				=E16-E26
28	Income taxes				=B9*E27
29	After-tax income				=E27-E28
30					
31	Preliminary CVP Calculations				
32	Target pretax profit for CVP analysis				=B8/(1-B9)
33	Fixed costs plus target pretax profit				=B7+E32
34					
35	CVP analysis in units	Youth Bikes	Road Bikes	Mtn. Bikes	Total Bikes
36	CVP calculation in units	=B21*\$E36	=C21*\$E36	=D21*\$E36	=E33/E18
37	Revenue	=B36*B4	=C36*C4	=D36*D4	=SUM(B37:D37)
38	Variable costs	=B36*B5	=C36*C5	=D36*D5	=SUM(B38:D38)
39	Contribution margin	=B37-B38	=C37-C38	=D37-D38	=E37-E38
40	Fixed costs				=B7
41	Pretax income				=E39-E40
42	Income taxes				=E41*B9
43	After-tax income				=E41-E42
44					
45	CVP analysis in revenues	Youth Bikes	Road Bikes	Mtn. Bikes	Total Bikes
46	CVP calculation in revenues	=\$E46*B22	=\$E46*C22	=\$E46*D22	=E33/E19
47	Variable costs	=B46*B5/B4	=C46*C5/C4	=D46*D5/D4	=SUM(B47:D47)
48	Contribution margin	=B46-B47	=C46-C47	=D46-D47	=E46-E47
49	Fixed costs				=B7
50	Pretax income				=E48-E49
51	Income taxes				=B9*E50
52	After-tax income				=E50-E51

SUMMARY

Q1 What Is Cost-Volume-Profit (CVP) Analysis, and How Is It Used for Decision Making?

Cost-Volume-Profit (CVP) Analysis

A technique that examines changes in profits in response to changes in sales volumes, costs, and prices

CVP Graph

Shows the relationship between total revenues and total costs; illustrates how an organization's profits are expected to change under different volumes of activity

Uses

Describe volume, revenues, costs, and profits:

- Values at breakeven or target profit:
 - Units sold
 - Revenues
 - Variable, fixed, and total costs
- Sensitivity of results to changes in:
 - Levels of activity –Selling price
 - Cost function –Sales mix
- Indifference point between alternatives
- Feasibility of planned operations

Assist with plans and decisions such as:

- Budgets
- Product emphasis
- Selling price
- Production or activity levels
- Employee work schedules
- Raw material purchases
- Discretionary expenditures such as advertising
- Proportions of fixed versus variable costs

Monitor operations by comparing expected and actual:

- Volumes, revenues, costs, and profits
- Profitability risk

Q2 How Are CVP Calculations Performed for a Single Product?**CVP Formulas**

CVP analysis in units needed to attain target profit:

$$Q = \frac{F + \text{Profit}}{\text{Contribution margin per unit}} = \frac{F + \text{Profit}}{P - V}$$

CVP analysis in revenues needed to attain target profit:

$$\text{Revenues} = \frac{F + \text{Profit}}{\text{Contribution margin ratio}} = \frac{F + \text{Profit}}{(P - V)/P} = \frac{F + \text{Profit}}{(\text{TR} - \text{TVC})/\text{TR}}$$

Pretax profit needed to achieve a given level of after-tax profit:

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

Q3 How Are CVP Calculations Performed for Multiple Products?**Use CVP Formulas for a Single Product, Except**

$$\text{Weighted average contribution margin per unit} = \frac{\text{Total expected contribution margin}}{\text{Total expected number of units}}$$

$$\text{Weighted average contribution margin ratio} = \frac{\text{Total expected contribution margin}}{\text{Total expected revenue}}$$

Q4 What Is the Breakeven Point?**Breakeven Point**

Level of operating activity at which revenues cover all fixed and variable costs, resulting in zero profit.

Calculation

Set target profit equal to zero in the CVP formula.

Q5 What Assumptions and Limitations Should Managers Consider When Using CVP Analysis?**CVP Assumptions**

- Operations within a relevant range of activity
- Linear cost function
 - Fixed costs remain fixed.
 - Variable cost per unit remains constant.
- Linear revenue function
 - Sales mix remains constant.
 - Prices remain constant.

Uncertainties

- Actual future volumes, revenues, and costs are unknown.
- CVP assumptions might not hold.

In Light of Assumptions and Uncertainties, Need to Evaluate:

- Quality of data used in CVP analyses
- Suitability of CVP analysis for the setting
- Sensitivity of CVP results to changes in data for important uncertainties

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Q6 How Are Margin of Safety and Operating Leverage Used to Assess Operational Risk?

Margin of Safety

$$\begin{aligned} \text{Margin of safety in units} &= \text{Actual or estimated units of activity} - \text{Units at breakeven point} \\ \text{Margin of safety in revenues} &= \text{Actual or estimated revenue} - \text{Revenue at breakeven point} \\ \text{Margin of safety percentage} &= \frac{\text{Margin of safety in units}}{\text{Actual or estimated units}} = \frac{\text{Margin of safety in revenues}}{\text{Actual or estimated revenues}} \end{aligned}$$

Degree of Operating Leverage

In terms of contribution margin:

$$\text{Degree of operating leverage} = \frac{\text{Contribution margin}}{\text{Profit}} = \frac{\text{TR} - \text{TVC}}{\text{Profit}} = \frac{(P - V) \times Q}{\text{Profit}}$$

In terms of fixed costs:

$$\text{Degree of operating leverage} = \frac{F}{\text{Profit}} + 1$$

Sensitivity of profits to changes in sales (units or revenues):

$$\% \text{ change in profit} = \% \text{ change in sales} \times \text{Degree of operating leverage}$$

Relationship Between Margin of Safety and Degree of Operating Leverage

$$\text{Margin of safety percentage} = \frac{1}{\text{Degree of operating leverage}}$$

Higher Operating Leverage (Lower Margin of Safety) Leads to:

- Greater risk of loss
- Accelerated profits above the breakeven point

KEY TO SYMBOLS

- | | |
|--|--|
| <p>e This question requires students to extend knowledge beyond the applications shown in the textbook.</p> <p>1 This question requires Step 1 skills (Identifying) in Steps for Better Thinking (Exhibit 1.10).</p> <p>2 This question requires Step 2 skills (Exploring) in Steps for Better Thinking (Exhibit 1.10).</p> | <p>3 This question requires Step 3 skills (Prioritizing) in Steps for Better Thinking (Exhibit 1.10).</p> <p>4 This question requires Step 4 skills (Envisioning) in Steps for Better Thinking (Exhibit 1.10).</p> |
|--|--|

Self-Study Problems

Self-Study Problem 1 Cost Function, Target Profit, Margin of Safety, Operating Leverage

Q1, Q3, Q5, Q6

Coffee Cart Supreme sells hot and iced coffee beverages and small snacks. The following is last month's income statement.

Revenue		\$5,000
Cost of beverages and snacks	\$2,000	
Cost of napkins, straws, etc.	500	
Cost to rent cart	500	
Employee wages	<u>1,000</u>	<u>4,000</u>
Pretax profit		1,000
Taxes		<u>250</u>
After-tax profit		<u><u>\$ 750</u></u>

REQUIRED:

- 2 A. What is the total cost function for Coffee Cart Supreme?
 e B. What is the tax rate for Coffee Cart Supreme?
 C. Calculate the amount of sales needed to reach a target after-tax profit of \$1,500.
 D. What was Coffee Cart Supreme's degree of operating leverage last month?
 E. What was Coffee Cart Supreme's margin of safety in revenue last month?
 F. What was Coffee Cart Supreme's margin of safety percentage last month?
 e G. Suppose next month's actual revenues are \$8,000 and pretax profit is \$2,000. Would actual costs be higher or lower than expected?
 2 H. Coffee costs are volatile because worldwide coffee production varies from year to year. Explain how this volatility affects the quality of the cost function for Coffee Cart Supreme.

Solution to Self-Study Problem 1

A. To estimate the cost function, we use judgment to classify costs as fixed, variable, or mixed. For a typical retail business, rent and wages are likely to be fixed. We estimate fixed costs as the sum of these two costs (\$500 + \$1,000 = \$1,500). It seems reasonable that the costs of beverages and snacks (\$2,000) and napkins, straws, etc. (\$500) would vary with revenues. We use the revenues as the cost driver to estimate variable costs as $\$2,500 \div \$5,000 = 0.50$, or 50% of revenues. Thus, the cost function is

$$TC = \$1,500 + (50\% \times \text{Revenue})$$

B. We use income tax expense and pretax profit from last month to estimate the tax rate:

$$\text{Tax rate} = \text{Taxes} \div \text{Pretax profit} = \$250 \div \$1,000 = 25\%$$

C. We first calculate the amount of pretax profit needed to achieve an after-tax profit of \$1,500.

$$\text{Targeted pretax profit} = \$1,500 \div (1 - 0.25) = \$2,000$$

The contribution margin ratio is

$$(\$5,000 - \$2,500) \div \$5,000 = 0.50 \text{ or } 50\%$$

We then perform the CVP calculation for revenues.

$$\text{Revenue} = (\$1,500 + \$2,000) \div 0.50 = \$3,500 \div 0.50 = \$7,000$$

D. We use the results of our previous computations to calculate the contribution margin, and we then calculate the degree of operating leverage:

$$\text{Contribution margin} = \$5,000 - \$2,500 = \$2,500$$

$$\text{Degree of operating leverage} = \text{Contribution margin} \div \text{Profit}$$

$$\text{Degree of operating leverage} = \$2,500 \div \$1,000 = 2.50$$

E. Before calculating the margin of safety, we need to calculate the breakeven point. Note that the margin of safety must be calculated in revenue dollars. We do not have unit or product mix information. The breakeven point is calculated as

$$\$1,500 \div 0.50 = \$3,000 \text{ in revenues}$$

Current revenues are \$5,000, so the margin of safety is calculated as

$$\text{Margin of safety} = \$5,000 - \$3,000 = \$2,000$$

F. We use the formula to calculate margin of safety percentage:

$$\text{Margin of safety percentage} = \$2,000 \div \$5,000 = 40\%$$

Note that we can check our previous degree of operating leverage computation as follows:

$$\text{Degree of operating leverage} = 1 \div \text{Margin of safety percentage} = 1 \div 0.40 = 2.50$$

G. The expected and actual costs at \$8,000 revenue are

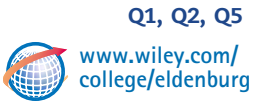
$$\text{Expected Costs} = \$1,500 + (50\% \times \$8,000) = \$5,500$$

$$\text{Actual Costs} = \$8,000 - \$2,000 = \$6,000$$

Actual costs are \$500 higher than expected.

H. When any costs are volatile, predicting them is problematic. Worldwide coffee prices are uncertain for many reasons, such as weather conditions in coffee growing areas, the ability of farmers to increase crops, and coffee demand patterns. In addition, broader factors such as changes in economies and political upheaval influence costs. All of these factors reduce our ability to develop a cost function that accurately predicts future costs, which means that the quality of the cost function is diminished.

Self-Study Problem 2 Sensitivity Analysis



The spreadsheet developed for the Magik Bicycles examples in this chapter is available on the Web at www.wiley.com/college/eldenburg. Download the template and use the spreadsheet to answer the following questions. A printout of the formulas used in the spreadsheet is available in Appendix 3A.

REQUIRED:

- 2 A. Examine the spreadsheet so that you understand how the cells in the data input section are referenced. When all of the decision variables are located in one place in the spreadsheet, accountants and managers can easily perform sensitivity analysis by changing values in the data input section. Why is it important to be able to change the spreadsheet easily to reflect changes in assumptions?
 - B. Suppose that Magik adds a helmet to each youth bike sold. The helmets cost \$25 each but incorporate new materials and an innovative design that has reduced injuries and deaths from children's bike accidents. Magik's managers believe that by advertising the new helmet as part of the youth bike package, sales will increase to 13,000. However, an advertising campaign will need to be undertaken to alert parents to the benefits of the new helmet. How much can Magik afford to spend on advertising and still expect to earn the original after-tax profit of \$455,000? Assume the selling price remains at \$200 per bike package.
- 3 C. Identify CVP input factors that you believe are uncertain for this decision, and use your judgment to determine a new value for each factor. Reflect these changes in the spreadsheet to see how they affect the breakeven point and profitability. Choose a best-case and worst-case scenario to present to the managers of Magik Bicycles. Make a list of the points you would include in a memo explaining your sensitivity analysis to the managers.

Solution to Self-Study Problem 2

- A. Accountants and managers will explore changes in more assumptions and vary the values within the spreadsheet more readily if it is easy to do. When these changes are made and the results are analyzed, managers better understand how unplanned changes in future operations might affect profitability. This knowledge allows them to more readily evaluate results and adjust operating plans.
- B. Exhibit 3.11 provides relevant parts of the spreadsheet with the changes. With increased sales of youth bikes from 10,000 to 13,000 and an increased variable cost from \$75 to \$100, expected pretax profits increase to \$700,000. Comparing \$700,000 to \$650,000 (Exhibit 3.2), Magik can spend up to \$50,000 on advertising to maintain its current level of profitability.
- C. Many different scenarios could occur. No single answer is always correct. Your answer depends on the assumptions that you make. Following are some example assumptions for the best and worst cases. Your most likely case should be between these two values.

One best case is that the new strategy is very popular with customers. More than 13,000 of the bikes are sold. The managers discover that customers are willing to pay a higher price for the bike, so they raise the price. In addition, manufacturing efficiency improves with the greater volume, reducing variable cost per unit. Also, fixed costs are lower than expected because the managers found some costs that could be reduced.

One worst case is that the helmets fail to attract customers. In fact, sales fail to meet original expectations; fewer than 10,000 are sold. Because the company produced extra bikes expecting an increase in demand, the managers lower the selling price to encourage additional sales. In addition, the company hires extra workers to meet the expected demand, and other costs such as insurance and electricity are higher than expected. These changes caused both the variable and fixed costs to be higher than originally planned.

Your memo to the managers should include the following:

- Explain the assumptions for the best case and worst case scenarios.
- Explain the reasoning behind the most likely case.
- Ask managers to consider beforehand how they would respond to the best- and worst-case scenarios.
- Make suggestions for monitoring the results for the youth bike.
- Encourage the managers to evaluate the advertising and product results, and make suggestions for improving the operation or dropping the new helmet, if plans are unsuccessful.

EXHIBIT 3.11
Spreadsheet for Magik
Bicycles Youth Helmet
Decision

	A	B	C	D	E
1					
2	Input section	Youth Bikes	Road Bikes	Mtn. Bikes	
3	Expected sales volume-units	13,000	18,000	12,000	
4	Price per unit	\$200	\$700	\$800	
5	Variable cost per unit	\$100	\$250	\$300	
6					
7	Fixed costs	\$14,700,000			
8	Desired after-tax profit	\$100,000	(enter zero for breakeven)		
9	Income tax rate	30%			
10					
11					
12	Contribution Margin	Youth Bikes	Road Bikes	Mtn. Bikes	Total Bikes
13	Units	13,000	18,000	12,000	43,000
14	Revenue	\$2,600,000	\$12,600,000	\$9,600,000	\$24,800,000
15	Variable costs	1,300,000	4,500,000	3,600,000	9,400,000
16	Contribution margin	\$1,300,000	\$8,100,000	\$6,000,000	\$15,400,000
17					
18	Contrib. margin per unit	\$100.00	\$450.00	\$500.00	\$358.14
19	Contrib. margin ratio	50.00%	64.29%	62.50%	62.10%
20					
21	Expected sales mix in units	30.23%	41.86%	27.91%	100.00%
22	Expected sales mix in revenues	10.48%	50.81%	38.71%	100.00%
23					
24	Expected Income				
25	Contribution margin (above)				\$15,400,000
26	Fixed costs				14,700,000
27	Pretax income				700,000
28	Income taxes				210,000
29	After-tax income				\$490,000

REVIEW Use the following boxes from the chapter to review key terms and key techniques, analyze chapter illustrations, improve your learning of new concepts, and practice ethical decision making:

Guide Your Learning 3.1: Key Terms (p. 91)

Guide Your Learning 3.4: Small Animal Clinic (p. 102)

Guide Your Learning 3.2: The Spotted Cow Creamery (Part 1) (p. 93)

Guide Your Learning 3.5: Key Terms (p. 106)

Guide Your Learning 3.3: The Spotted Cow Creamery (Part 2) (p. 98)

Focus on Ethical Decision Making: Temporary Labor (p. 107)

QUESTIONS

- 3.1 If a firm has a mixed cost function, a 10% increase in sales volume should increase income by more than 10%. Explain why.
- 3.2 Explain how to calculate a weighted average contribution margin per unit.
- 3.3 An organization experiences a 20% increase in pretax profits when revenues increase 20%. Assuming linearity, what do you know about the organization's cost function?
- 3.4 What is the effect on a firm's breakeven point of a lower income tax rate?
- 3.5 To estimate revenues, costs, and profits across a range of activity, we usually assume that the cost and revenue functions are linear. What are the specific underlying assumptions for linear cost and revenue functions, and how reasonable are these assumptions?
- 3.6 Explain the relationship between margin of safety percentage and degree of operating leverage.
- 3.7 How do volume discounts from suppliers affect our assumption that the cost function is linear? Explain how we incorporate this type of cost into a CVP analysis.
- 3.8 Explain the term *sales mix* in your own words. How does sales mix affect the contribution margin?
- 3.9 How are CVP analysis and breakeven analysis related?
- 3.10 Can the margin of safety ever be negative? Explain your answer.
- 3.11 Describe three uses for CVP analysis.
- 3.12 Explain how CVP analysis can be used to make decisions about increases in advertising costs.
- 3.13 Under what circumstances will managers want sensitivity analysis around results from a CVP analysis?

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EXERCISES**3.14 Target profit, not-for-profit breakeven**

Q2, Q4

- A. The variable cost per gift basket is \$2, fixed costs are \$5,000 per month, and the selling price of a basket is \$7. How many baskets must be produced and sold in a month to earn a pretax profit of \$1,000?
- e B. The Community Clinic (a not-for-profit medical clinic) received a lump-sum grant from the City of Tucson of \$460,000 this year. The fixed costs of the clinic are expected to be \$236,000. The average variable cost per patient visit is expected to be \$7.64 and the average fee collected per patient visit is \$4.64. What is the breakeven volume in patient visits?

3.15 CVP graph

Q2, Q4

- A. Create a CVP graph using the information in Exercise 3.14, part (A). Explain the information in the graph.
- e B. Create a CVP graph using the information in Exercise 3.14, part (B). Explain the information in the graph.

3.16 Cost function, breakeven

Q2, Q4

- e A. The average cost per unit was \$234 at a volume of 1,200 units and \$205 at a volume of 1,400 units. The profit was \$24,000 at the lower volume. Estimate the variable cost per unit.
- e B. Sparkle Car Wash Supplier sells a hose washer for \$0.25 that it buys from the manufacturer for \$0.12. Variable selling costs are \$0.02 per hose washer. Breakeven is currently at a sales volume of \$10,600 per month. What are the monthly fixed costs associated with the washer?
- e C. Monthly fixed costs are \$24,000 when volume is at or below 200 units and \$36,000 when monthly volume is above 200 units. The variable cost per unit is \$200 and the selling price is \$300 per unit. What is the breakeven quantity?

- 3.17 Profit, price for target profit** The Martell Company has recently established operations in a competitive market. Management has been aggressive in its attempt to establish a market share. The price of the product was set at \$5 per unit, well below that of the company's major competitors. Variable costs were \$4.50 per unit, and total fixed costs were \$600,000 during the first year.

REQUIRED:

- A. Assume that the firm was able to sell 1 million units in the first year. What was the pretax profit (loss) for the year?
- e B. Assume that the variable cost per unit and total fixed costs do not increase in the second year. Management has been successful in establishing its position in the market. What price must be set to achieve a pretax profit of \$25,000? Assume that sales remain at 1 million units.

- 3.18 Cost function, breakeven** Data for the most recent three months of operations for the RainBeau Salon appear here:

	March	April	May
Number of appointments	1,600	1,500	1,900
Hair dresser salaries	\$14,000	\$14,000	\$18,000
Manicurist salaries	12,000	12,000	16,000
Supplies	900	750	950
Utilities	600	480	400
Rent	1,000	1,000	1,000
Miscellaneous	3,500	3,450	3,580
Total costs	<u>\$32,000</u>	<u>\$31,680</u>	<u>\$39,930</u>

A general cost-of-living salary increase occurred at the beginning of May.

REQUIRED:

- 2 A. What is the total cost function for RainBeau Salon?
- B. If the average fee per appointment is \$25, estimate the appointments required in June to break even.

- 3.19 Breakeven, target profit, ROI target profit** Madden Company projected its income before taxes for next year as shown here. Madden is subject to a 40% income tax rate.

CMA

Q2, Q4

Sales (160,000 units)	\$8,000,000
Cost of sales	
Variable costs	2,000,000
Fixed costs	<u>3,000,000</u>
Pretax profit	<u>\$3,000,000</u>

- REQUIRED:**
- A. What is Madden’s breakeven point in units sold for the next year?
 - B. If Madden wants \$4.5 million in pretax profit, what is the required level of sales in dollars?
 - e C. If Madden’s net assets are \$36 million, what amount of revenue must be achieved for Madden to earn a 10% after-tax return on assets?

3.20 Breakeven, target profit, cost changes, selling price Laraby Company produces a single product. It sold 25,000 units last year with the following results.

CMA

Sales	\$625,000
Variable costs	375,000
Fixed costs	<u>150,000</u>
Income before taxes	100,000
Income taxes (45%)	<u>45,000</u>
After-tax profit	<u>\$ 55,000</u>

In an attempt to improve its product, Laraby’s managers are considering replacing a component part that costs \$2.50 with a new and better part costing \$4.50 per unit during the coming year. A new machine would also be needed to increase plant capacity. The machine would cost \$18,000 and have a useful life of 6 years with no salvage value. The company uses straight-line depreciation on all plant assets.

- REQUIRED:**
- A. What was Laraby Company’s breakeven point in units last year?
 - B. How many units of product would Laraby Company have had to sell in the past year to earn \$77,000 in after-tax profit?
 - e C. If Laraby Company holds the sales price constant and makes the suggested changes, how many units of product must be sold in the coming year to break even?
 - D. If Laraby Company holds the sales price constant and makes the suggested changes, how many units of product will the company have to sell to make the same after-tax profit as last year?
 - e E. If Laraby Company wishes to maintain the same contribution margin ratio, what selling price per unit of product must it charge next year to cover the increased materials costs?

3.21 Target profit, progressive income tax rates, CVP graph Dalton Brothers pay 15% in taxes on income between \$1 and \$40,000. All income above \$40,000 is taxed at 40%. The firm’s variable costs as a percent of revenues are 60%. Annual fixed costs are \$250,000.

Q3

- REQUIRED:**
- e A. What level of sales must the firm achieve to earn income after taxes of \$150,000?
 - e B. Prepare a CVP graph for Dalton.

3.22 Breakeven, selling price, target profit with price and cost changes All-Day Candy Company is a wholesale distributor of candy. The company services grocery, convenience, and drug stores in a large metropolitan area. Small but steady growth in sales has been achieved by the All-Day Candy Company over the past few years, but candy prices also have been increasing. The company is reformulating its plans for the coming fiscal year. The following data were used to project the current year’s after-tax income of \$100,400.

CMA

Average selling price	\$4.00 per box
Average variable costs	
Cost of candy	\$2.00 per box
Selling costs	<u>0.40 per box</u>
Total	<u>\$2.40 per box</u>
Annual fixed costs	
Selling	\$160,000
Administrative	<u>280,000</u>
Total	<u>\$440,000</u>

Expected annual sales (390,000 boxes) = \$1,560,000
 Tax rate = 40%

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Candy manufacturers have announced that they will increase prices of their products an average of 15% in the coming year because of increases in raw material (sugar, cocoa, peanuts, and so on) and labor costs. All-Day Candy Company expects that all other costs will remain the same as during the current year.

- REQUIRED:**
- A. What is All-Day Candy Company's breakeven point in boxes of candy for the current year?
 - e B. What average selling price per box must All-Day Candy Company charge to cover the 15% increase in the variable cost of candy and still maintain the current contribution margin ratio?
 - e C. What volume of sales in dollars must the All-Day Candy Company achieve in the coming year to maintain the same after-tax income as projected for the current year if the average selling price of candy remains at \$4.00 per box and the cost of candy increases 15%?

3.23 Breakeven, operating leverage, cost function decision You are the advisor of a Junior Achievement group in a local high school. You need to help the group make a decision about fees that must be paid to sell gardening tools at the Home and Garden Show. The group sells a set of tools for \$20.00. The manufacturing cost (all variable) is \$6 per set. The Home and Garden Show coordinator allows the following three payment options for groups exhibiting and selling at the show:

1. Pay a fixed booth fee of \$5,600.
2. Pay a fee of \$3,800 plus 10% of all revenue from tool sets sold at the show.
3. Pay 15% of all revenue from tool sets sold at the show.

- REQUIRED:**
- A. Compute the breakeven number of tool sets for each option.
 - B. Which payment plan has the highest degree of operating leverage?
 - e C. Which payment plan has the lowest risk of loss for the organization? Explain.
 - D. At what level of revenue should the group be indifferent to options 1 and 2?
 - E. Which option should Junior Achievement choose, assuming sales are expected to be 1,000 sets of tools? Explain.

3.24 ROI target profit, foreign exchange rates Borg Controls has a net investment in its German subsidiary of \$2.68 million. The firm attempts to earn a 15% pretax return on its investment. Variable costs for the German subsidiary are 60% of revenues. Annual fixed costs are 321,000. For the current year, the manager of the German subsidiary anticipates revenues of 1.7 million. The exchange rate is expected to be 1.2 = \$1.

- REQUIRED:**
- e A. If operations meet expectations, what is the rate of return that Borg Controls will earn from its German subsidiary? (*Hint:* Calculate the rate of return by dividing pretax income by the net investment.)
 - e B. What level of revenue in euros would be required of the subsidiary for the parent to earn exactly a 15% rate of return in dollars, assuming no changes in the exchange rate?

3.25 Target profit, margin of safety, operating leverage The following budget data apply to Newberry's Nutrition:

Sales (100,000 units)		\$1,000,000
Costs		
Direct materials	\$300,000	
Direct labor	200,000	
Fixed factory overhead	100,000	
Variable factory overhead	150,000	
Marketing and administration	<u>160,000</u>	
Total costs		<u>910,000</u>
Budgeted pretax income		<u>\$ 90,000</u>

Direct labor workers are paid hourly wages and go home when there is no work. The marketing and administration costs include \$50,000 that varies proportionately with production volume. Assume that sales and production volumes are equal.

- REQUIRED:**
- Compute the number of units that must be sold to achieve a target after-tax income of \$120,000, assuming the tax rate is 40%.
 - Calculate the margin of safety in both revenues and units.
 - Calculate the degree of operating leverage.

3.26 **Breakeven, target profit, margin of safety, operating leverage** Pike Street Taffy makes and sells taffy in a variety of flavors in a shop located in the local public market. Data for a recent week are as follows:

Revenue (2,000 lbs. @ \$4.80 per lb.)		\$9,600
Cost of ingredients	\$3,200	
Rent	800	
Wages	<u>4,800</u>	<u>8,800</u>
Pretax income		800
Taxes (20%)		<u>160</u>
After-tax income		<u>\$ 640</u>

All employees work standard shifts, no matter how much taffy is produced or sold.

- REQUIRED:**
- Calculate the breakeven point in units and in revenue.
 - Calculate the number of units and the amount of revenues that would be needed for after-tax income of \$3,000.
 - Calculate the margin of safety in units and the margin of safety percentage.
 - Calculate the degree of operating leverage.

3.27 **Breakeven, target profit, margin of safety** Vines and Daughter manufactures and sells swimsuits for \$40 each. The estimated income statement for 2005 is as follows:

Sales	\$2,000,000
Variable costs	<u>1,100,000</u>
Contribution margin	900,000
Fixed costs	<u>765,000</u>
Pretax profit	<u>\$ 135,000</u>

- REQUIRED:**
- Compute the contribution margin per swimsuit and the number of swimsuits that must be sold to break even.
 - What is the margin of safety in the number of swimsuits?
 - Suppose the margin of safety was 5,000 swimsuits in 2004. Are operations more or less risky in 2005 as compared to 2004? Explain.
 - Compute the contribution margin ratio and the breakeven point in revenues.
 - What is the margin of safety in revenues?
 - Suppose next year's revenue estimate is \$200,000 higher. What would be the estimated pretax profit?
 - Assume a tax rate of 30%. How many swimsuits must be sold to earn an after-tax profit of \$180,000?

PROBLEMS

3.28 **Cost function, breakeven, quality of information, relevant range** Oysters Away picks, shucks, and packs oysters and then sells them wholesale to fine restaurants across the state. The income statement for last year follows:

Revenue (based on sales of 2,000 cases of oysters)		\$200,000
Expenses:		
Wages for pickers, shuckers, and packers	\$100,000	
Packing materials	20,000	
Rent and insurance	25,000	
Administrative and selling	<u>45,000</u>	<u>190,000</u>
Pretax income		10,000
Taxes (20%)		<u>2,000</u>
After-tax income		<u>\$ 8,000</u>

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Pickers, shuckers, and packers are employed on an hourly basis and can be laid off whenever necessary. Salespeople mostly deliver the product and are paid on a salaried basis.

- REQUIRED:**
- e A. Estimate the cost function for Oysters Away.
 - B. What is the breakeven point in cases for Oysters Away?
 - C. The manager thinks that the company will harvest and sell 3,000 cases of oysters next year. Estimate the after-tax income.
 - 2 D. Oysters Away harvested and sold 2,000 cases in each of the last several years. What does this suggest about the quality of the income information you calculated in part (C)?
 - 1 E. Describe reasons why the cost function developed for the relevant range up to 2,000 cases might not hold for 2,001 to 3,000.

3.29
Q1, Q3, Q5



Relevant information, breakeven, target profit, price, uncertainties Francesca would like to lease a coffee cart in Aspen, Colorado. The lease is \$800 per month and a city license to sell food and beverages costs \$20 per month. The lessor of the stand has shown Francesca records indicating that gross revenues average \$32 per hour. The out-of-pocket costs for ingredients are generally about 40% of gross revenues. Last year she paid 25% of her income in federal taxes.

Francesca pays \$1,000 per month for her condominium. She could store the cart overnight in the condo's garage, which is currently unused. Real estate developers in Aspen estimate that about 20% of the cost of a residential building is for the garage.

At present, Francesca is earning \$2,400 per month as a ski instructor for one of the big ski areas. In the summertime she earns about the same income as a kayaking instructor.

- REQUIRED:**
- A. List each piece of quantitative information in this problem. For each item, indicate whether it is relevant to Francesca's decision and explain why.
 - e B. If Francesca leases the cart and works 30 days in a month, how many hours will she have to work each day, on average, to be at least as well off financially as she is in her current job?
 - e C. If Francesca wants to work only 25 days per month, how much will revenues have to increase for her to work 4 hours per day and be as financially well off as she is in her current job?
 - 1 D. Can Francesca be certain that her revenues will average \$32 per hour? Why or why not?
 - 1 E. What other information might help Francesca with this decision?

3.30
Q3, Q4, Q5



Sales mix, multiple product breakeven, uncertainties, quality of information Keener produces two products: regular boomerangs and premium boomerangs. Last month 1,200 units of regular and 2,400 units of premium were produced and sold. Average prices and costs per unit for the month are displayed here.

	Regular	Premium
Selling price	\$22.15	\$45.30
Variable costs	4.31	6.91
Product line fixed costs	8.17	24.92
Corporate fixed costs	5.62	5.62
Operating Profit	<u>\$ 4.05</u>	<u>\$ 7.85</u>

Product line fixed costs can be avoided if the product line is dropped. Corporate fixed costs can be avoided only if the firm goes out of business entirely. You may want to use a spreadsheet to perform calculations.

- REQUIRED:**
- A. Assuming the sales mix remains constant, how many units of premium will be sold each time a unit of regular is sold?
 - B. What are the total fixed product line costs for each product?
 - C. What are the total corporate fixed costs?
 - D. What is the overall corporate breakeven in total revenue and for each product, assuming the sales mix is the same as last month's?
 - e E. What is the breakeven in revenues for regular boomerangs, ignoring corporate fixed costs?
 - e F. Why is the breakeven for regular boomerangs different when we calculate the individual product breakeven versus the combined product breakeven?

(continued)

- 2 G. When managers monitor the profitability of regular boomerangs, are corporate fixed costs relevant? Explain.
- 1 H. CVP analysis assumes that the sales mix will remain constant. Explain why managers generally cannot know for certain what their sales mix will be.
- 2 I. What is the effect of uncertainty about the sales mix on the quality of the information obtained from CVP analyses?

3.31
Q1, Q2, Q4

Cost function, marginal cost, opportunity cost, usefulness of CVP A neighbor asked for your help preparing a grant for a not-for-profit after-school art program that would benefit elementary school children in the neighborhood. He wants to charge low fees for most children, but also offer some scholarships for low-income children. He needs to have one staff person for every six children to meet state regulations. He can use high school student volunteers for two of these positions, but is concerned about potential absences on their part if he relies on them for the state count. He would like the program to serve at least 30 children, and more, if possible.

He wants you to help him decide on the fees to charge and also to determine how many students could receive scholarships.

REQUIRED:

- A. Think about the costs involved in an after-school program. Assume that your neighbor can use the local elementary school for free.
 - 2 1. List costs that will be incurred for the program, and categorize them as fixed, variable, or mixed.
 - 2 2. For each variable cost, choose a potential cost driver. Explain your choice.
- 2 B. Do you think the cost structure would be primarily fixed or primarily variable? Explain. Remember, even though staff work only part time, they will have a regular schedule to meet the state regulations of six children per staff member.
- C. Suppose one of the staff members has only one child to help. What is the marginal cost for three scholarships?
- e D. Suppose the program is fully subscribed by fee-paying children. What is the opportunity cost per scholarship?
- 2 E. Will CVP analysis help your neighbor choose a fee that would cover at least 10 scholarships? Explain how you would set up a spreadsheet so that your neighbor could perform sensitivity analysis to make more informed decisions.

3.32
Q1, Q2, Q4, Q5



Breakeven, CVP, potential cost structure change, employee reaction Ersatz manufactures a single product. The following income statement shows two different levels of activity, which are assumed to be within Ersatz's relevant range. You may want to use a spreadsheet to perform calculations.

Ersatz, Inc. Income Statement		
	Activity Levels	
Volume	1,000 units	1,500 units
Sales @ \$100 each	\$100,000	\$150,000
Less variable expenses		
Manufacturing @ \$40 each	40,000	60,000
Selling @ \$10 each	10,000	15,000
Administration @ \$6 each	6,000	9,000
Contribution margin	44,000	66,000
Less fixed expenses		
Manufacturing	10,000	10,000
Selling	11,000	11,000
Administration	20,000	20,000
Pretax income	\$ 3,000	\$ 25,000

REQUIRED:

- A. What is Ersatz's breakeven point in units?
- B. Draw a CVP chart showing the two levels of activity and the breakeven point.
- C. If Ersatz plans to sell 1,300 units, what will pretax income be?

(continued)

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- 3 D. Your boss asked you to draft an e-mail response to Ersatz's major stockholder, who wants to know why pretax income increases by more than 800% when sales increase by just 50%. Both your boss and the stockholder are busy people and expect short answers.
- E. Management expects that variable costs and selling prices will rise by 3%, but fixed costs will not change. What will the new breakeven point be? Explain the result.
- e F. Management wants to change the way that sales representatives are paid. At present, sales representatives are paid \$11,000 + \$10 per unit. Management will replace this formula with a payment of \$20 per unit. At what level of sales will it make no difference in income which cost function is used?
- G. Add the new cost function to the preceding CVP chart.
- H. Which of the two cost functions will minimize selling expenses assuming that sales are above the indifference level calculated in part (F)?
- 2 I. How would sales representatives be likely to respond to the new payment system?
- 2 J. Discuss the pros and cons to the company of changing the way sales representatives are paid.

3.33
Q1, Q2, Q4, Q5, Q6



Breakeven, avoidable fixed costs, price, CVP assumptions, operating risk Last year's income statement for King Salmon Sales follows.

Revenue (100,000 lbs.)		\$800,000
Expenses		
Fish	\$200,000	
Smoking materials	20,000	
Packaging materials	30,000	
Labor (wages)	300,000	
Administrative	150,000	
Sales commissions	10,000	
Total expenses		<u>710,000</u>
Income		<u>\$ 90,000</u>

The fishing season is only three to four months long, so labor costs (wages) are for employees who are college students and work in the summer. They are hired only as needed.

REQUIRED:

- e A. The state government curtailed fishing because of low fish counts. Because of this restriction, King Salmon Sales can only buy 50,000 pounds. Assume the administrative cost is incurred only if the company sells salmon. Assuming the managers will decide to operate if the company can at least break even, should they operate this year? (*Hint:* Calculate the breakeven quantity.) Provide calculations and explain your answer.
- e B. Now assume that the administrative costs continue regardless of whether the company sells salmon. Assuming the managers will decide to operate if the company can at least break even, should they operate this year? Provide calculations and explain your answer.
- e C. Because of the salmon shortage, suppose that retail salmon prices are increasing. What is the breakeven price for King Salmon? Assume that administrative costs continue regardless of whether the company sells salmon.
- D. Suppose the managers rely on the preceding CVP analysis to decide whether to operate the business. What assumptions are they making?
- 2 E. How reasonable are these CVP assumptions?
- F. Suppose the owner of King Salmon Sales asked you about the company's cost structure. Because volumes of fish fluctuate a great deal from one year to the next, the owner is wondering if some way can be found to reduce the risk of an operating loss. Write a brief memo to explain how the proportion of fixed and variable costs affects the risk of loss when operations are close to the breakeven point.

★ **3.34**
Q1, Q2, Q4, Q5



Cost function, breakeven, target profit, uncertainties and bias, interpretation Joe Davies is thinking about starting a company to produce carved wooden clocks. He loves making the clocks. He sees it as an opportunity to be his own boss, making a living doing what he likes best.

Joe paid \$300 for the plans for the first clock, and he has already purchased new equipment costing \$2,000 to manufacture the clocks. He estimates that it will cost \$30 in materials (wood,

clock mechanism, and so on) to make each clock. If he decides to build clocks full time, he will need to rent office and manufacturing space, which he thinks would cost \$2,500 per month for rent plus another \$300 per month for various utility bills. Joe would perform all of the manufacturing and run the office, and he would like to pay himself a salary of \$3,000 per month so that he would have enough money to live on. Because he does not want to take time away from manufacturing to sell the clocks, he plans to hire two salespeople at a base salary of \$1,000 each per month plus a commission of \$7 per clock.

Joe plans to sell each clock for \$225. He believes that he can produce and sell 300 clocks in December for Christmas, but he is not sure what the sales will be during the rest of the year. However, he is fairly sure that the clocks will be popular because he has been selling similar items as a sideline for several years. Overall, he is confident that he can pay all of his business costs, pay himself the monthly salary of \$3,000, and earn at least \$4,000 more than that per month. (Ignore income taxes.)

**REQUIRED:
ANALYZE
INFORMATION**

The following questions will help you analyze the information for this problem. Do not turn in your answers to these questions unless your professor asks you to do so.

- A. Perform analyses to estimate the number of clocks Joe would need to manufacture and sell each year for his business to be financially successful:
 1. List all of the costs described and indicate whether each cost is (a) a relevant fixed cost, (b) a relevant variable cost, or (c) NOT relevant to Joe's decision.
 2. Calculate the contribution margin per unit and the contribution margin ratio.
 3. Write down the total cost function for the clocks and calculate the annual breakeven point in units and in revenues.
 4. How many clocks would Joe need to sell annually to earn \$4,000 per month more than his salary?
- 1 B. Identify uncertainties about the CVP calculations:
 1. Explain why Joe cannot know for sure whether his actual costs will be the same dollar amounts that he estimated. In your explanation, identify as many uncertainties as you can. (*Hint:* For each of the costs Joe identified, think about reasons why the actual cost might be different than the amount he estimated.)
 2. Identify possible costs for Joe's business that he has not identified. List as many additional types of cost as you can.
 3. Explain why Joe cannot know for sure how many clocks he will sell each year. In your explanation, identify as many uncertainties as you can.
- 2 C. Discuss whether Joe is likely to be biased in his revenue and cost estimates.
- 2 D. Explain how uncertainties and Joe's potential biases might affect interpretation of the breakeven analysis results.

**REQUIRED:
WRITTEN ASSIGNMENT**

Suppose Joe has asked for your advice. Turn in your answers to the following.

- 3 E. Use the information you learned from the preceding analyses to write a memo to Joe with your recommendations. Attach to the memo a schedule showing relevant information. As appropriate, refer to the schedule in the memo.

**3.35
Q1, Q5**

ETHICS

CVP sensitivity analysis, bias, quality of information Jasmine Krishnan has been taking entrepreneurship courses as part of her business degree. She developed a plan to start a travel agency specializing in spring break trips for students.

She learned how to develop CVP analysis in her cost accounting class. Now she is preparing pro forma (i.e., forecasted) income statements for a brochure about her plans for the travel agency. She wants to use the information from the CVP as a basis for the statements. Her entrepreneurship professor criticized her business plan because Jasmine included too small an amount for liability insurance. However, when she included the amount suggested by her father's insurance agent, she had to set prices quite high, cut back on the amount she planned as her salary, find lower quality hotels for the students, or take some combination of these actions. She thought that hotel quality and prices would affect sales volumes negatively and did not want to risk incurring losses from low revenues during her first few years. She also needed a base level of salary to at least pay for her living expenses.

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She decided to ask friends and relatives to invest in her travel agency to ensure she had enough capital for the first few years. Once her reputation was well established, she assumed that higher customer volumes would cover all of her expected costs. She was confident that her planned trips would attract enough students each year to cover most of her costs. From focus groups on campus, she learned which types of trips were most appealing to other students. Now she planned to use sensitivity analysis to solve for volumes that would make the pro forma statements look attractive to investors.

- REQUIRED:**
- 1 A. In general, what information do we hope to gain from performing sensitivity analyses? Explain.
 - 2 B. Explain how bias might enter into Jasmine’s sensitivity analyses.
 - 2 C. How might Jasmine’s bias affect the quality of the investment brochure information?
 - 1 D. Identify a potential ethical problem for Jasmine.
 - 3 E. When you consider the well-being of Jasmine’s family and friends, how would you recommend that Jasmine use sensitivity analysis for her brochure? Explain.



3.36
Q1, Q4, Q5

Small business owners, CVP research on the internet The Internet provides many resources to help small business owners successfully manage their businesses. Resources include information about common techniques used for planning and managing operations.

- REQUIRED:**
- 2 A. Why are small business owners often unaware of common business techniques such as CVP analysis?
 - 2 B. Why might CVP analysis be even more useful to small business owners than to managers of large organizations? (*Hint:* Consider whether information about the margin of safety and size of potential losses might be especially important for people who own small businesses.)
 - 1 C. Use an Internet search engine to locate Web sites that provide information about the terms *breakeven analysis* and *cost-volume-profit analysis*. Also search for these terms on Web sites designed explicitly to help small business owners, such as the U.S. Small Business Administration (www.sba.gov). Summarize what your research tells you about the uses and usefulness of breakeven and CVP analysis.
 - 3 D. Suppose you are trying to help a small business owner learn to use breakeven and CVP analysis. Write a memo to the owner explaining what you think the owner should do and include appropriate references to Internet resources that would be useful to the owner. Assume that you have already had a brief conversation with the owner about breakeven and CVP analysis, and the owner expressed an interest in learning more. Focus on communicating effectively by avoiding unnecessarily technical language and concentrating on the most important points.



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☆ **3.37**
Q1, Q3, Q4, Q5, Q6



Cost function, operating leverage, keeping or dropping a business The university’s Wildcat Lair caters to students and serves sandwiches and beverages. It has been reporting losses in past months. In July, for example, the loss was \$5,000.

Revenue		\$ 70,000
Expenses		
Purchases of prepared food	\$21,000	
Serving personnel	30,000	
Cashiers	5,500	
Administration	10,000	
University surcharge	7,000	
Utilities	1,500	75,000
Loss		\$ (5,000)

The Lair purchases prepared food directly from University Food Services. This charge varies proportionately with the number and kind of meals served. Personnel paid by the Lair serve the food, tend the cash register, bus and clean tables, and wash dishes. The staffing levels rarely change; the existing staff can usually handle daily fluctuations in volume. Administrative costs are primarily the salaries of the manager and her office staff. Because the university provides support services for the

Lair, such as payroll, human resources, and other administrative support, the university charges a surcharge of 10% of its revenues. Utility costs are the costs of cooling, heating, and lighting during its normal operating hours.

The university's management is considering closing the Wildcat Lair because it has been operating at a loss.

**REQUIRED:
ANALYZE
INFORMATION**

The following questions will help you analyze the information for this problem. Do not turn in your answers to these questions unless your professor asks you to do so.

- e A. What is the breakeven point for Wildcat Lair from the university's perspective (including the university surcharge)? What is the breakeven point from Wildcat Lair's perspective (excluding the university surcharge)?
- B. Define and calculate the degree of operating leverage for the Lair, ignoring the university surcharge.
- 1 C. From the perspective of university management, is the university surcharge a relevant cost in deciding whether to close the Lair? Why or why not?
- 1 D. Identify possible ways that operations could be modified so that some of the fixed costs become variable costs.
- 2 E. Given the Lair's cost function and operating leverage, describe possible benefits of modifying operations so that some of the fixed costs become variable costs.

**REQUIRED:
WRITTEN
ASSIGNMENT**

Turn in your answers to the following.

- 2 F. From the perspective of university management, describe the pros and cons of closing the Wildcat Lair.
- 3 G. Suppose you are the manager of the Wildcat Lair. Write a memo to persuade the university management to keep the club open.

3.38
Q1, Q2, Q4, Q5, Q6



Not-for-profit breakeven price, budget alternatives The Elder Clinic, a not-for-profit organization, provides limited medical services to low-income elderly patients. The manager's summary report for the past four months of operations is reproduced here.

	March	April	May	June	Total
Patient visits	849	821	778	842	3,290
Patient fees	\$ 4,230	\$ 4,180	\$ 3,875	\$ 4,260	\$ 16,545
Medical staff salaries	13,254	13,256	13,254	14,115	53,879
Medical supplies used	3,182	3,077	2,934	3,175	12,368
Administrative salaries	3,197	3,198	3,197	3,412	13,004
Rent	1,000	1,000	1,000	1,100	4,100
Utilities	532	378	321	226	1,457
Other expenses	2,854	2,776	2,671	2,828	11,129
Total expenses	24,019	23,685	23,377	24,856	95,937
Operating surplus (loss)	\$ (19,789)	\$ (19,505)	\$ (19,502)	\$ (20,596)	\$ (79,392)

The clinic receives an operating subsidy from the city, but unfortunately, the operating loss incurred through June (\$79,392) is larger than anticipated. Part of the problem is the salary increase that went into effect in June, which had been overlooked when the budget was submitted to the city last year. To compound the problem, the warm summer months traditionally bring with them an increase in heat-related health problems. Thus, the clinic is likely to experience an increase in patient visits during July.

The accountant made the following assumptions in developing the cost function:

- Salaries are fixed, and June values are used.
- Medical supplies vary with patient visits.
- Rent and utilities are fixed, and last period's costs are used.
- Other expenses are mixed and using regression, fixed cost is \$702 and variable cost is \$2.53 per patient visit.

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Clinic management is considering an increase in patient fees to reduce losses.

- REQUIRED:**
- e A. Develop a cost function for this data. You may have done this for Chapter 2, and in that case use that cost function. Solve for the average patient fee necessary to break even assuming there are 940 patient-visits using the cost function you developed. Compare this new fee with the average patient fee charged during March through June.
 - 1 B. Suppose the clinic raises its patient fees to break even. What problems do you see from the elderly patients' perspective if the fee is raised?
 - 2 C. In this setting, would an increase in fees be likely to affect patient volume? What problems do you see from the clinic's perspective if the fee is raised?
 - 1 D. Other than raising the fee, what ideas might the clinic consider to balance the budget?

3.39
Q1, Q3, Q4, Q5, Q6



Cost function, target profit, operating leverage, CVP graph, owner goals Elina Siljander owns Elina's Stained Glass in Helsinki, Finland. The business produces and sells three different types of stained glass windows: small, medium, and large. Elina has two full-time employees who work regular schedules to cut glass and assemble the windows. She borrowed money from the bank to start the business and pay living expenses. She is concerned that her cash flows might not be high enough either to pay herself or to repay the bank loan. She would like to generate approximately 10,000 (euros) in pretax profit each month to cover her living expenses and repay the loan.

The following revenue and cost information covers the past four months:

	June	July	August	September
Revenues	9,050	10,531	12,946	16,116
Raw materials and supplies	1,745	2,433	3,074	4,029
Labor	3,880	4,041	4,246	4,282
Rent	2,000	2,000	2,000	2,200
Miscellaneous	525	701	747	793
Profit	900	1,356	2,879	4,812

- REQUIRED:**
- 2 A. Develop a cost function for Elina's Stained Glass.
 - B. Determine the level of revenue Elina's Stained Glass must generate to achieve the targeted profit of 10,000 per month.
 - C. Calculate Elina's degree of operating leverage for September.
 - 2 D. Interpret Elina's degree of operating leverage.
 - E. Create a CVP graph showing the breakeven point, target profit, and margin of safety.
 - 3 F. Write a memo to Elina with recommendations about ways she might achieve her goals.

3.40
Q1, Q3, Q4, Q5



Building and using a CVP financial model Toddler Toy Company sells baby dolls, teddy bears, and toy cars. The managers established a preliminary budget using the following assumptions. They would now like to evaluate the sensitivity of budgeted results to different sets of assumptions.

	Toddler Toy Company Assumptions for Coming Year		
	Baby Dolls	Teddy Bears	Toy Cars
Volume	200,000	125,000	225,000
Price	\$ 3.50	\$ 2.75	\$ 3.15
Variable costs	\$ 2.05	\$ 1.75	\$ 2.45
Fixed costs	\$65,000	\$125,000	\$35,000
Target pretax income =	\$0		
Investment =	\$2 million		
Capacity =	1 million units		

- REQUIRED:**
- A. Create a spreadsheet that the managers can use for sensitivity analysis. (*Hint:* Use the Magik Bicycles spreadsheet in Exhibit 3.2 and Appendix 3A to help you set up a spreadsheet with a data input box.) Modify input data in the spreadsheet to answer the following parts of this problem. You may wish to add cell references for percentage changes in prices, volumes, and costs.

(continued)

- B.** Assume that the volume of dolls sold increases to 225,000 units with no change in fixed or variable costs. What is the new pretax income? Does the number produced by your financial model appear to be reasonable? (Manually estimate the increase in pretax income if volume increases and fixed costs remain constant. Compare this figure to your spreadsheet result.)
- C.** Based on the original assumptions, what is the effect on pretax income if variable costs increase by 5% for each of the three product lines? Assume that nothing else changes.
- D.** Return to the original assumptions. Assume that a sales manager proposed a new advertising campaign to boost sales volume. The campaign would cost \$30,000 and is estimated to increase the volume of each product as follows:
- Baby doll sales increase by 20,000 units.
Teddy bear sales increase by 7,500 units.
Toy car sales increase by 30,000 units.
- What would be the effect on pretax income if this plan were adopted?
- E.** Return to the original assumptions. Now assume that due to competition, Toddler Toys must cut prices on each of its three products by 20%. In addition, a new advertising campaign costing \$45,000 must be instituted to counteract bad publicity. Given these assumptions, what is the new breakeven point?
- F.** Return to the original assumptions. What would be the pretax income if Toddler Toys increases the price of all three products by 10% and the volume of each product line decreases by 5%?
- e G.** Given the same assumptions as in part (F), how many units must Toddler Toys sell to earn a target pretax income of \$100,000? A target pretax income of \$150,000? A pretax return on investment (ROI) of 10%? (*Hint:* To determine the target pretax income, multiply 10% times amount invested.)
- H.** Spreadsheets for financial modeling allow sensitivity analysis of revenues, costs, and quantities such as estimated product volumes.
- 1** 1. Explain why it is not possible to perfectly estimate revenues, costs, and quantities.
 - 2** 2. Explain how sensitivity analysis can help managers evaluate the pros and cons of alternatives.
 - 2** 3. Explain how manager bias might influence estimates of revenues, costs, and quantities.

3.41 **Building and using a CVP financial model** The following information for Pet Palace, a large retail store that sells pet-related merchandise, was recorded for the first quarter. The store tracks merchandise according to product type. The category “Other” includes accessories such as dog beds, leashes, kitty litter boxes, bird cages, and so on. The company is considering several different strategies to improve operations for the next quarter.



Input Data	Food	Toys	Pets	Other	Total
Revenue	\$500,000	\$150,000	\$75,000	\$200,000	\$925,000
Variable cost	200,000	50,000	60,000	50,000	360,000
Fixed cost					550,000
Tax rate					25%

- REQUIRED:**
- e A.** Create a spreadsheet that Pet Palace managers can use for sensitivity analysis. Modify information in the data input section and answer the questions in the following parts.
- B.** What is Pet Palace’s breakeven point? What total revenue is necessary for a target after-tax income of \$100,000?
- C.** Pet Palace managers are considering their advertising campaign for the next period. They believe they could spend an additional \$10,000 on advertising for a product line and increase sales by 10%. One manager wants to increase advertising on pets because that product line is currently the smallest. Another manager believes the ads should promote the most profitable products, but they are not sure which products those would be. What is the after-tax income if pets are promoted? What is the most profitable product? What is the after-tax income if that product is promoted?
- 1 D.** What factors, other than the quantitative results, might influence managers’ decisions to increase advertising?

BUILD YOUR PROFESSIONAL COMPETENCIES

3.42 Focus on Professional Competency: Decision Modeling *Model building for decision making, quality of analysis* Review the following definition and elements for the Decision Modeling competency.⁹

DEFINITION: *Individuals preparing to enter the accounting profession must be able to use strategic and critical approaches to decision-making. They must objectively consider issues, identify alternatives, and choose and implement solution approaches in order to deliver services and provide value.*

ELEMENTS FOR THIS COMPETENCY INCLUDE

Level 1	Level 2	Level 3	Level 4
1. Identifies problems, potential solution approaches, and related uncertainties	2. Objectively identifies strengths, weaknesses, opportunities, and threats associated with a specific scenario, case, or business activity 3. Uses quantitative techniques to explore the likelihood of alternative scenarios 4. Organizes and evaluates information, alternatives, cost/benefits, risks and rewards of alternative scenarios 5. Employs model-building techniques to quantify problems or test solutions	6. Links data, knowledge, and insights together for decision-making purposes	7. Engages in continuous improvement and constructs new models over time 8. Makes decisions over time as a result of engaging in continuous improvement and constructing new models

REQUIRED:

- A.** Focus on the competency elements 1, 4, 6, and 8, which relate to the use of information in management decision making. Answer the following questions:
- ① 1. What types of management decisions were addressed in Chapter 3?
 - ① 2. What types of quantitative analyses were used in Chapter 3 to address these decisions?
 - ② 3. Were quantitative results the only information used by managers to make decisions? Why or why not?
 - ② 4. Review the decision-making illustrations in Chapter 3. Provide an example where data, knowledge, and insights were linked together. Explain.
 - ② 5. Review the decision-making illustrations in Chapter 3. Provide an example where an improvement in analysis led to improved decision making. Explain.
- B.** Focus on competency element 5, which addresses the use of model-building techniques. Explain how CVP analysis (a model-building technique) can be used to (1) quantify problems and (2) test solutions.
- C.** Focus on competency elements 2 and 3, which relate to the use of quantitative techniques to explore alternative scenarios. Answer the following questions:
- ② 1. What is CVP sensitivity analysis? How is it used to quantitatively explore the likelihood of alternative scenarios?
 - ② 2. What is the degree of operating leverage? How is it used to quantitatively explore the likelihood of alternative scenarios?
- D.** Focus on competency element 6, which relates to the use of information in decision making. Suppose you plan to perform CVP analysis for an organization.
- ① 1. What types of data do you need to perform the CVP analysis?
 - ② 2. Why is knowledge about the organization critical to your ability to perform a high-quality analysis? What do you need to know?

⁹The definition and elements are reprinted with permission from AICPA; copyright © 1978–2000 & 2003 by American Institute of Certified Public Accountants. The AICPA's Core Competency Framework can be accessed at eca.aicpaservices.org.

3.43 **Integrating Across the Curriculum: Economics and Marketing** *Nonlinear revenue, maximize profits, CVP assumptions* Hollis Company manufactures and markets a regulator used to maintain high levels of accuracy in timing clocks. The market for these regulators is limited and highly dependent upon the selling price.



Based upon past relationships between the selling price and the resulting demand, as well as an informal survey of customers, management derived the following demand function, which is highly representative of the actual relationships.

$$D = 1,000 - 2P$$

where

D = Annual demand in units

P = Price per unit

The estimated manufacturing and selling costs for the coming year are as follows:

Variable costs	
Manufacturing	\$75 per unit
Selling	\$25 per unit
Fixed costs	
Manufacturing	\$24,000 per year
Selling	\$6,000 per year

- REQUIRED:**
- e **A.** Write the function for total revenue. [*Hint:* Recall that total revenue equals price times quantity ($P \times Q$), and the demand function determines the quantity sold (Q .)]
 - e **B.** Write the total cost function, substituting the demand function for Q .
 - e **C.** Perform a search on the Internet to find a quadratic equation calculator or go to www.wiley.com/college/eldenburg. Use the calculator to find the breakeven points. (*Hint:* Set the revenue function equal to the cost function and algebraically convert the equation to quadratic form: $AP^2 + BP + C = 0$.)
 - e **D.** Draw a graph with total revenue and total cost for Q between zero and 1,000 units. Mark the breakeven points.
 - e **E.** Determine the selling price that Hollis Company should charge per regulator and the number of regulators the company should sell to maximize the company's profits for the coming year. (*Hint:* Recall that profit is maximized when marginal revenue equals marginal cost. You must be able to differentiate a simple function to answer this question.)
 - F.** Which CVP assumption does this situation violate? Explain.
 - G.** For the past several years, assume the company sold regulators at the price you calculated in part (E) and that volume varied between 375 and 425 units per year. In this situation, discuss whether it would be appropriate to use CVP analysis to estimate the company's profits.

