Cost–Volume–Profit Analysis

3

How "The Biggest Rock Show Ever" Turned a Big Profit[1]

On its recent tour across North America, Europe, and Asia, the rock band U2 performed on an imposing 164-foot-high stage that resembled a spaceship, complete with a massive video screen and footbridges leading to ringed catwalks. U2 used three separate stages—each one costing nearly $40 million. Additional expenses for the tour were $750,000 daily. As a result, the tour's success depended not only on the quality of each night's concert but also on recouping its tremendous fixed costs—costs that did not change with the number of fans in the audience.

Kevin Dietsch/UPI/Newscom

To cover its high fixed costs and make a profit, U2 needed to sell a lot of tickets. To maximize the tour's revenue, tickets were sold for as little as $30, and a unique in-the-round stage configuration boosted stadium capacities by roughly 20%. The plan worked. U2 shattered attendance records in most of the venues it played. By the end of the tour, the band played to more than 7 million fans, racking up almost $736 million in ticket and merchandise sales … and went into the history books as the biggest tour ever. As you read this chapter, you will begin to understand how and why U2 made the decision to lower prices.

Businesses that have high fixed costs have to pay particular attention to the "what-ifs" behind decisions because making the wrong choices can be disastrous. Examples of well-known companies that have high fixed costs are American Airlines and General Motors. When companies have high fixed costs, they need significant revenues just to break even. In the airline industry, for example, companies' fixed costs are so high that the profits most airlines make come from the last two to five passengers who board each flight! Consequently, when revenues at American Airlines dropped, it was forced to declare bankruptcy. In this chapter, you will see how cost–volume–profit (CVP) analysis helps managers minimize such risks.

▶ Learning Objectives

1. Identify the essential elements of cost–volume–profit analysis and calculate the breakeven point (BEP).

2. Apply the CVP model to calculate a target operating profit before interest and tax.

3. Distinguish among contribution, gross, operating, and net income margins, and apply the CVP model to calculate target net income.

4. Apply the CVP model in decision making and explain how sensitivity analysis can help managers both identify and manage risk.

5. Analyze the implications of uncertainty on decision models.

6. Interpret the results of CVP analysis in complex strategic, multi-product, and multiple cost driver situations.

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[1] *Sources:* Edna Gundersen. 2009. U2 turns 360 stadium into attendance-shattering sellouts. *USA Today*, October 4; Ray Waddell. 2011. U2's "360" tour gross: $736,137,344! *Billboard*, July 29.

Cost–volume–profit (CVP) analysis is a model to analyze the behaviour of net income in response to changes in total revenue, total costs, or both. In reality, businesses operate in a complex environment; a *model* reduces that complexity by using simplifying assumptions to focus on only the relevant relationships. The most important elements in a model affect one another in a predictable way. In this chapter, when we determine the breakeven point (BEP), we include *all* business function costs in the value chain, not just those of production. The **breakeven point (BEP)** is the point at which total revenue minus total business function costs is $0.

Essentials of CVP Analysis

The CVP model depends on understanding the effects of cost behaviour on profit, and identifies only the relevant relationships. The following assumptions identify relevant information required to complete a CVP analysis:

◆ Changes in the sales volume and production (or purchase) volume are identical (purchase volume would apply to a merchandiser). The ending balances in all inventories are zero. Everything purchased is used in production; everything produced is sold. For a merchandiser, the sales volume of finished goods purchased for resale is identical to the sales volume sold.

◆ All costs are classified as either fixed (FC) or variable (VC). All mixed costs are broken into their respective fixed and variable components. The fixed costs include *both* manufacturing *and* non-manufacturing fixed costs. The total variable costs include both manufacturing and non-manufacturing variable costs.

◆ All cost behaviour is linear (a straight line) within the relevant volume range.

◆ The sales price per unit, variable costs per unit, and total fixed costs and sales (or production) volume are known. The MIS provides all of this information.

◆ Either the product sold or the product mix remains constant, although the volume changes.

◆ All revenue and costs can be calculated and compared without considering the time-value of money.

We know that total revenue is the product of total sales volume or quantity (Q) of units sold multiplied by the price per unit. We also know that total variable cost is the product of total Q units produced multiplied by the cost per unit, and together with fixed costs (constant cost regardless of production volume) comprise total costs. Based on the simplifying assumption that Q sold $= Q$ produced, the relationship among relevant elements of the CVP model upon which the BEP can be calculated is:

$$\text{Operating income} = (\text{Unit sales price} \times Q) - (\text{Unit variable cost} \times Q) - (\text{Fixed costs}) \quad (1)$$

At break even, operating income is zero. So for the break even point, we can rearrange equation (1) above to be:

$$(\text{Unit sales price} \times Q) = (\text{Unit variable cost} \times Q) + (\text{Fixed costs})$$

CVP Analysis: An Example

Decision Framework

We will begin by looking at an example based on known information about operating income (net income before interest and taxes). Then we will determine the required combination of sales volume and unit sales price to break even. In the CVP analysis, only one factor, sales volume (Q), changes.

Example: Wei Shao is considering selling Do-All Software, a home-office software package, at a computer convention in Vancouver. Wei knows she can purchase this software from a computer software wholesaler at $120 per package, with the privilege of returning all unsold packages and receiving a full $120 refund per package. She also knows that she must pay Computer

Conventions, Inc. $2,000 for the booth rental at the convention. She will incur no other costs. Should she rent a booth?

Wei faces an uncertain future as she analyzes the information she has at hand. A decision framework can be applied in this situation:

1. **Identify the problem and uncertainties.** Wei has to resolve two important uncertainties— the unit sales price she can charge and the number of packages (Q) she can sell at that price.

2. **Obtain information.** Wei obtains the relevant information on the variable and fixed costs to attend the conference and purchase the software. She uses her own information on sales volume and her previous experience at a similar convention in Seattle four months ago. Wei also gathers published industry information. She realizes that customers may purchase their software from competitors and wants to match her volume and purchase price to customer demand.

3. **Predict the future.** Wei predicts that she can charge $200 for Do-All Software. She is confident of the straight line or linear relationship between volume, price, and total revenue within her relevant range of 30 to 60 units. However, Wei remains uncertain. Have there been important changes in customer demand over the last four months? Her regular sales in the last couple of months have been lower than she expected. Is she too optimistic or biased in her predictions?

4. **Make decisions by choosing among alternatives.** Wei will use the CVP relationship to help her decide among alternatives available for pricing and quantity sold.

5. **Implement the decision, evaluate performance, and learn.** If Wei attends the convention then she will know her outcome or actual profit. This is important feedback to compare with her predicted profit. Wei can learn from this comparison how to make better decisions in the future.

Cost–Volume–Profit Analysis

Wei knows that the booth-rental cost of $2,000 is a fixed cost because it must be paid even if she sells nothing. Wei's variable cost per Do-All Software package is $120 for quantities between 30 and 60 packages. Wei sorts her data into classifications of revenue and total variable cost, then tests two volumes of sales shown in a spreadsheet:

	Wei Sells 5 Packages	Wei Sells 40 Packages
Revenue	$ 1,000 ($200 per package × 5 packages)	$8,000 ($200 per package × 40 packages)
Total variable cost	600 ($120 per package × 5 packages)	4,800 ($120 per package × 40 packages)
Contribution margin	$ 400	$3,200

The only numbers that change from selling different quantities are total revenues and total variable costs. The difference between total revenues and total variable costs is called the **contribution margin**. That is:

$$\text{Revenue} - \text{Total variable cost} = \text{Contribution margin}$$

What is the *breakeven price (BEP)* in sales volume Q, where operating income = $0? Wei does not yet know her predicted operating income, nor does she know what her minimum Q must be to cover her costs. By including the fixed cost of $2,000 in her analysis, Wei can calculate how operating income changes as Q changes. If she sells only 5 packages, then she will suffer an operating loss of $1,600 (= $400 − $2,000) and operating income < $0. If she sells 40 packages then she will enjoy a positive operating income of $1,200 (= $3,200 − $2,000) and operating income > $0.

	Wei Sells 5 Packages	Wei sells 40 Packages
Revenue	$ 1,000 ($200 per package × 5 packages)	$ 8,000 ($200 per package × 40 packages)
Total variable cost	600 ($120 per package × 5 packages)	4,800 ($120 per package × 40 packages)
Contribution margin	$ 400	$ 3,200
Fixed cost	2,000	2,000
Operating income	$(1,600)	$ 1,200

But rather than simply using trial and error, Wei can use the CVP model

$$Q \text{ sold} = Q \text{ purchased for sale}$$

If Wei assumes that operating income = $0, she can easily calculate the sales volume Q at which she will break even:

$$\$0 = Q \times (\text{Unit price} - \text{Unit variable cost}) - \text{Fixed cost} \tag{2}$$

Based on the information she has, Wei can substitute the financial values and complete her calculation as follows:

$$\$0 = Q \times (\$200 - \$120) - \$2{,}000$$
$$\$0 = Q \times (\$80) - \$2{,}000$$
$$\$2{,}000 = \$80Q$$
$$\frac{\$2{,}000}{\$80} = Q$$
$$25 = Q$$

Contribution margin per unit is the difference between selling price and variable cost per unit. In the Do-All Software example, contribution margin per unit is $80 per unit (= $200 price per unit − $120 variable cost per unit). Simplifying her model further:

$$\$0 = Q \times \text{Contribution margin per unit} - \text{Fixed cost} \tag{3}$$

When the unit sales price is $200, Wei knows that each unit sold covers the variable cost of $120 per unit and provides $80 (= $200 − $120) that can be used to cover her fixed cost of $2,000. By substituting the known amounts into the formula, Wei can calculate the BEP of 25 units (= $2000 ÷ $80):

$$\$0 = Q \times (\$80) - \$2{,}000$$
$$\$2{,}000 = \$80Q$$
$$\frac{\$2{,}000}{\$80} = Q$$
$$25 = Q$$

Exhibit 3-1 shows the result of calculating the BEP in two formats. On the right is the familiar financial statement of comprehensive income format. On the left is a **contribution statement of comprehensive income**, which groups costs as either variable or fixed according to their behaviour. The format of the report does not affect the dollar value of the operating income, since the revenue and total costs are identical. What has changed is the classification system used to report the results.

Expressing CVP Relationships

To make good decisions using CVP analysis, we must understand these relationships and the structure of the contribution statement of comprehensive income in Exhibit 3-1.

Exhibit 3-1 Contribution Statement Compared to Financial Statement Format

Quantity Purchased and Sold = 25			
Contribution Format		**Financial Statement of Comprehensive Income Format**	
Revenue ($200 × 25)	$5,000	Revenue ($200 × 25)	$5,000
− Total variable cost ($120 × 25)	3,000	− Total cost of sales (COS)	3,000
Total contribution margin	2,000	Gross margin	2,000
− Fixed costs (always a total)	2,000	− Total period cost	2,000
Operating income	$ 0	Operating income	$ 0

	A	B	C	D	E	F	G	H
1				**Number of Packages Sold**				
2				**0**	**1**	**5**	**25**	**40**
3	Revenues	$ 200	per package	$ 0	$ 200	$ 1,000	$5,000	$8,000
4	Variable costs	120	per package	0	120	600	3,000	4,800
5	Contribution margin	80	per package	0	80	400	2,000	3,200
6	Fixed costs	2,000		2,000	2,000	2,000	2,000	2,000
7	Operating income			$(2,000)	$(1,920)	$(1,600)	$ 0	$1,200

Exhibit 3-2 Contribution Statement of Comprehensive Income for Different Quantities of Do-All Software Packages Sold

There are three related ways (we will call them methods) to think more deeply about and model CVP relationships:

1. The equation method
2. The contribution margin method
3. The graph method

   The equation method and the contribution margin method are most useful when managers want to determine operating income at a few specific levels of sales (for example, in Exhibit 3-2, there are 1, 5, 25, and 40 units sold). The graph method helps managers visualize the relationship between units sold and operating income over a wide range of quantities of units sold. As we shall see later in the chapter, different methods are useful for different decisions.

Equation Method

Each column in Exhibit 3-2 is expressed as an equation.

$$\text{Revenues} - \text{Variable costs} - \text{Fixed costs} = \text{Operating income}$$

How are revenues in each column calculated?

$$\text{Revenues} = \text{Selling price } (SP) \times \text{Quantity of units sold } (Q)$$

How are variable costs in each column calculated?

$$\text{Variable costs} = \text{Variable cost per unit } (VCU) \times \text{Quantity of units sold } (Q)$$

So,

$$\left[\left(\begin{array}{c}\text{Selling}\\\text{price}\end{array} \times \begin{array}{c}\text{Quantity of}\\\text{units sold}\end{array}\right) - \left(\begin{array}{c}\text{Variable cost}\\\text{per unit}\end{array} \times \begin{array}{c}\text{Quantity of}\\\text{units sold}\end{array}\right)\right] - \begin{array}{c}\text{Fixed}\\\text{costs}\end{array} = \begin{array}{c}\text{Operating}\\\text{income}\end{array} \quad (4)$$

Equation 4 becomes the basis for calculating operating income for different quantities of units sold. For example, if you go to cell F7 in Exhibit 3-2, the calculation of operating income when Wei sells 5 packages is

$$(\$200 \times 5) - (\$120 \times 5) - \$2,000 = \$1,000 - \$600 - \$2,000 = -\$1,600$$

Contribution Margin Method

Rearranging equation 4,

$$\left[\left(\begin{array}{c}\text{Selling}\\\text{price}\end{array} - \begin{array}{c}\text{Variable cost}\\\text{per unit}\end{array}\right) \times \left(\begin{array}{c}\text{Quantity of}\\\text{units sold}\end{array}\right)\right] - \begin{array}{c}\text{Fixed}\\\text{costs}\end{array} = \begin{array}{c}\text{Operating}\\\text{income}\end{array}$$

$$\left(\begin{array}{c}\text{Contribution margin}\\\text{per unit}\end{array} \times \begin{array}{c}\text{Quantity of}\\\text{units sold}\end{array}\right) - \begin{array}{c}\text{Fixed}\\\text{costs}\end{array} = \begin{array}{c}\text{Operating}\\\text{income}\end{array} \quad (5)$$

In our Do-All Software example, contribution margin per unit is $80 (= $200 − $120), so when Wei sells 5 packages,

$$\text{Operating income} = (\$80 \times 5) - \$2,000 = -\$1,600$$

Equation 5 expresses the basic idea we described earlier—each unit sold helps Wei recover $80 (in contribution margin) of the $2,000 in fixed costs.

The calculation for the contribution margin method can also be rearranged to show the breakeven point (BEP) in relation to fixed costs and the contribution margin per unit.

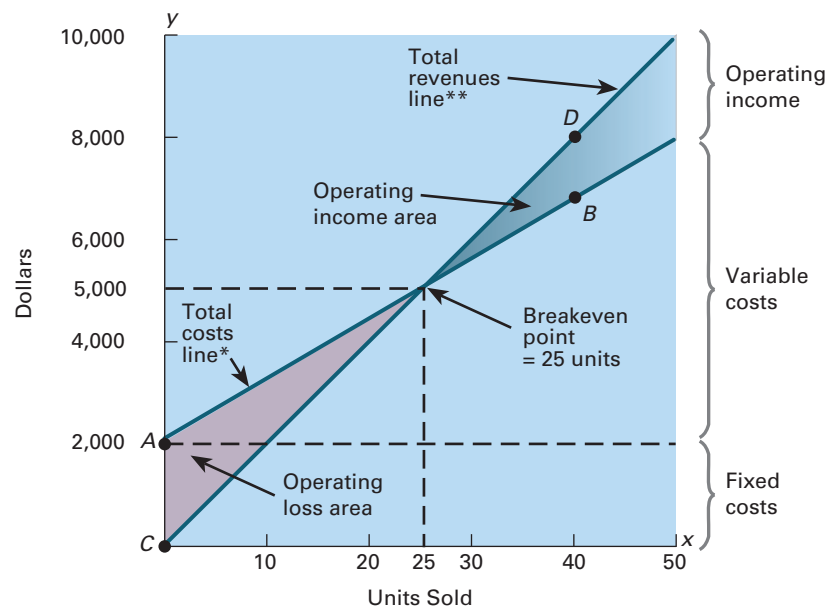$$\text{BEP} = \frac{\text{Total fixed costs}}{\text{Contribution margin per unit}}$$

Graph Method

In the graph method, we represent total costs and total revenues graphically. Each is shown as a line on a graph. Exhibit 3-3 illustrates the graph method for Do-All Software sales. Because we have assumed that total costs and total revenues behave in a linear fashion, we need only two points to plot the line representing each of them.

1. **Total costs line.** The total costs line is the sum of fixed costs and variable costs. Fixed costs are $2,000 for all quantities of units sold within the relevant range. To plot the total costs line, use as one point the $2,000 fixed costs at zero units sold (point **A**) because variable costs are $0 when no units are sold. Select a second point by choosing any other convenient output level (say, 40 units sold) and determine the corresponding total costs. Total variable costs at this output level are $4,800 (= 40 units × $120 per unit). Remember, fixed costs are $2,000 at all quantities of units sold within the relevant range, so total costs at 40 units sold equal $6,800 (= $2,000 + $4,800), which is point **B** in Exhibit 3-3. The total costs line is the straight line from point **A** through point **B**.

2. **Total revenues line.** One convenient starting point is $0 revenues at 0 units sold, which is **point C** in Exhibit 3-3. Select a second point by choosing any other convenient output level and determining the corresponding total revenues. At 40 units sold, total revenues are $8,000 (= $200 per unit × 40 units), which is point **D** in Exhibit 3-3. The total revenues line is the straight line from point **C** through point **D**.

   Profit or loss at any sales level can be determined by the vertical distance between the two lines at that level in Exhibit 3-3. For quantities fewer than 25 units sold, total costs exceed total revenues, and the purple area indicates operating losses. For quantities greater than 25 units sold, total revenues exceed total costs, and the blue-green area indicates operating incomes. At 25 units sold, total revenues equal total costs. Wei will break even by selling 25 packages.

Exhibit 3-3 Cost–Volume–Profit Graph for Do-All Software Sales

*Slope of the total costs line is the variable cost per unit = $120
**Slope of the total revenues line is the selling price = $200

Contribution Margin Percentage: Breakeven Point in Revenue

Instead of expressing contribution margin as a dollar amount per unit, we can also express it as a percentage. **Contribution margin percentage** (also called **contribution margin ratio**) equals the contribution margin per unit divided by the selling price per unit:

$$\text{Contribution margin percentage} = \frac{\$80}{\$200} = 0.40, \text{ or } 40\%$$

The contribution margin percentage tells us how many pennies per $1.00 of revenue contribute to paying fixed costs. For example, a contribution margin percentage of 40% means for each $1.00 a customer pays for Do-All Software, $0.40 contributes to paying fixed cost.

The contribution margin percentage enables us to solve for values with partial data. For example, how do you calculate the breakeven point in revenue when you do not know the sales price per unit? The solution is shown below:

$$\frac{\text{Breakeven}}{\text{revenue}} = \frac{\text{Fixed costs}}{\text{Contribution margin \%}} = \frac{\$2,000}{0.40} = \$5,000$$

Proof: $\$5,000 \div \$200 = 25$ units

From previous calculations, we know the BEP in units is 25.

Using CVP to Calculate a Target Operating Income

The breakeven point (BEP) can be calculated as either the minimum sales quantity or the minimum revenue required to avoid a loss. However, the point of for-profit business is to earn a profit, not to break even. The CVP model can also be used to calculate a target operating income.

Let's go back to the example of Wei Shao and Do-All Software. Wei can apply her model to determine what her quantity purchased and sold must be to make a positive operating income. Instead of setting Operating income = $0, it is set to equal a non-zero amount. The method of calculating this target quantity is identical to the method already described. Wei selects $1,500 as her target operating income.

$$\$1,500 = Q \times (\text{Unit sales price} - \text{Unit variable cost}) - \text{Fixed cost}$$
$$Q \times (\$200 - \$120) - \$2,000 = \$1,500$$
$$\$80 \times Q = \$2,000 + \$1,500$$
$$Q = \$3,500 \div \$80 \text{ per unit} = 43.75 \text{ units}$$

Alternatively, Wei knows the contribution margin per unit and can calculate the Q required to achieve a target operating income of $1,500 by starting at the second line of the solution, treating the target operating income as if it were a fixed cost. This is exactly what we have done when adding the $1,500 to the $2,000 to obtain $3,500. The $80 is the contribution margin per unit. Dividing $3,500 by the contribution margin per unit gives the identical answer of $Q = 43.75$ units:

$$\frac{\text{Volume of units}}{\text{required to be sold}} = \frac{\text{Fixed costs} + \text{Target operating income}}{\text{Contribution margin per unit}} \qquad (6)$$

$$\frac{\text{Volume of units}}{\text{required to be sold}} = \frac{\$2,000 + \$1,500}{\$80 \text{ per unit}} = 43.75 \text{ units}$$

Proof:

Revenue, $200 per unit × 43.75 units	$8,750
Variable costs, $120 per unit × 43.75 units	5,250
Contribution margin, $80 per unit × 43.75 units	3,500
Fixed costs	2,000
Operating income	$1,500

Of course, Wei cannot sell 75% of one Do-All package. If she rounds down to $Q = 43$ units she will bring in only \$3,440, which is less than the \$3,500 she needs to cover her \$2,000 fixed cost plus a target operating income of \$1,500. Wei must round up to $Q = 44$ units to reach her target.

Finally, Wei can use different information—fixed cost, target operating income, and the contribution margin percentage of 40%—to calculate her target revenue without first calculating her target Q. She will simply divide the sum of fixed cost plus her target operating income by the contribution margin percentage to obtain the target revenue required, as shown:

$$\text{Revenue needed to earn } \$1,500 = \frac{\$2,000 + \$1,500}{0.40} = \frac{\$3,500}{0.40} = \$8,750$$

Contribution Margin, Gross Margin, Operating Margin, and Net Income Margin

The CVP model enables us to clearly distinguish the contribution margin, which provides information for CVP analysis. Recall that there are two formats in which costs can be classified: the contribution and the financial format. Both formats report identical costs, but the costs are classified differently. The difference between contribution and gross margin is shown in the two equations below:

$$\text{Revenue} - \text{Cost of goods sold} = \text{Gross margin}$$

$$\text{Revenue} - \text{Total variable costs} = \text{Contribution margin}$$

Gross margin is a measure of competitiveness—how much a company can charge for its products over and above the cost of either purchasing (cost of sales) or producing them (cost of goods sold). The size of the gross margin depends on the successful competitive strategy of a company. The gross margin can be expressed as a total, as an amount per unit, or as a percentage (called **gross margin percentage**).

Operating margin has the same meaning as operating income. It is the result of deducting all business function costs from revenue. Neither interest nor tax expense is considered a business function cost. The operating margin percentage is simply the operating income divided by revenue. It does not matter what format is used to report costs—because total costs are identical, the reported operating income will be identical. **Net income margin** is an alternative technical term for net income. The non-technical term that is readily recognized is *net profit margin*. The **net income margin percentage** is calculated by dividing net income by revenue.

Target Net Income and Income Taxes

So far we have ignored the effect of income taxes when calculating the sales volume required to achieve a target income. The after-tax profit, however, is what matters to any business. Targets are set in terms of net income. In a real situation, managers must gather information on tax. In our example we will assume a corporate tax rate of 40%.

Let's return to the Do-All Software example. Wei's new problem is to calculate the required sales volume Q to earn a *net* income of \$960, assuming an income tax rate of 40%. Using the contribution margin format:

$$\text{Target operating income} = \text{Revenue} - \text{Total variable costs} - \text{Fixed costs}$$

Assuming there is no interest expense, a 40% tax rate means the company retains 60% of its operating income. The company's net income = Operating income × (1 − Tax rate), or simply:

$$\frac{\text{Net income}}{1 - \text{Tax rate}} = \text{Operating income}$$

It is now straightforward to calculate the number of units that must be sold to achieve a target net income based on a target operating income. First, using the relationship between revenue and total costs, both variable and fixed:

$$\frac{\text{Target net income}}{1 - \text{Tax rate}} = \text{Revenue} - \text{Total variable costs} - \text{Fixed costs}$$

Substituting numbers from our Do-All Software example:

$$\frac{\$960}{1 - 0.40} = (\$200 \times Q) - (\$120 \times Q) - \$2,000$$

$$\$1,600 = (\$200 \times Q) - (\$120 \times Q) - \$2,000$$

$$\$80 \times Q = \$3,600$$

$$Q = \$3,600 \div \$80 \text{ per unit} = 45 \text{ units}$$

Alternatively, we can use the contribution margin and calculate Q as shown:

$$\frac{\text{Target net income}}{1 - \text{Tax rate}} = \text{Target operating income}$$

$$\frac{\text{Fixed costs} + \dfrac{\text{Target net income}}{1 - \text{Tax rate}}}{\text{Contribution margin per unit}} = \text{Volume of units required to be sold}$$

$$\frac{\$2,000 + \dfrac{\$960}{1 - 0.40}}{\$80} = \frac{\$2,000 + \$1,600}{\$80 \text{ per unit}} = 45 \text{ units} = \begin{array}{l}\text{Volume of units} \\ \text{required to be sold}\end{array}$$

Proof:		
	Revenue, $200 per unit × 45 units	$9,000
	Variable costs, $120 per unit × 45 units	5,400
	Contribution margin	3,600
	Fixed costs	2,000
	Operating income	1,600
	Income taxes, $1,600 × 0.40	640
	Net income	$ 960

Recall that when we needed to calculate Q to achieve a target operating income, we obtained the rounded-up value of $Q = 44$ units. This is not enough, however, to achieve our target net income. But focusing the analysis on target net income instead of target operating income will never change the BEP. This is because, by definition, operating income at the breakeven point is $0, and no income taxes are paid when there is no operating income.

Using CVP Analysis to Make More Complex Decisions

CVP Analysis for Decision Making

CVP analysis is useful for calculating the units that need to be sold to break even, or to achieve a target operating income or target net income. Managers also use CVP analysis to guide other decisions, many of them strategic decisions. Consider a decision about choosing additional features for an existing product. Different choices can affect selling prices, variable cost per unit, fixed costs, units sold, and operating income. CVP analysis helps managers make product decisions by estimating the expected profitability of these choices.

▶ **LO 4**

Apply the CVP model in decision making and explain how sensitivity analysis can help managers both identify and manage risk.

Strategic decisions invariably entail risk. CVP analysis can be used to evaluate how operating income will be affected if the original predicted data are not achieved—say, if sales are 10% lower than estimated. Evaluating this risk affects other strategic decisions a company might make. For example, if the probability of a decline in sales seems high, a manager may take actions to change the cost structure to have more variable costs and fewer fixed costs. We return to our earlier example to illustrate how CVP analysis can be used for strategic decisions concerning advertising and selling price.

Decision to Advertise

Wei anticipates she will sell 40 units if she attends the convention. At 40 units, her operating income will be $1,200. However, if Wei pays $500 for an advertisement in the convention brochure, then she anticipates her sales volume will increase to 44 units. Advertising, in this case, is a fixed cost because it must be paid even if Wei sells no units at all. Will her operating profit increase? The following table presents the CVP analysis:

	40 Packages Sold With No Advertising (1)	44 Packages Sold With Advertising (2)	Difference (3) = (2) − (1)
Revenue ($200 × 40; $200 × 44)	$8,000	$8,800	$800
Variable costs ($120 × 40; $120 × 44)	4,800	5,280	480
Contribution margin ($80 × 40; $80 × 44)	3,200	3,520	320
Fixed costs	2,000	2,500	500
Operating income	$1,200	$1,020	$(180)

Operating income decreases from $1,200 to $1,020. Clearly, if the goal is to increase operating income, this is not the correct decision. Notice that this conclusion can be seen in the third column, which predicts the difference with and without advertising. If Wei advertises, then contribution margin will increase by $320 (revenue, $800 − variable costs, $480), *and* fixed costs will increase by $500, resulting in a $180 decrease in operating income (= $320 − $500).

As you become more familiar with CVP analysis, it is more effective to evaluate the financial results of different alternatives based only on those values that differ. It is the differences that affect your decision. Differences are *relevant* information about the consequences of each choice.

Decision to Reduce Selling Price

Wei now wonders if it's a good idea to reduce the selling price to $175 instead of $200. At this price, Wei anticipates she will sell 50 units instead of 40 units. At this higher volume level, the software wholesaler who supplies Do-All Software will sell the packages to Wei for $115 per unit instead of $120. Should Wei reduce the selling price? The following analysis tells Wei the answer is no:

Contribution margin from lowering price to $175: ($175 − $115) per unit × 50 units	$3,000
Contribution margin from maintaining price at $200: ($200 − $120) per unit × 40 units	3,200
Change in contribution margin from lowering price	$ (200)

The contribution margin decreases by $200. The fixed costs of $2,000 will not change under either option; therefore, operating income will decrease by $200.

Wei could also ask, "At what price can I sell 50 units (purchased at $115 per unit) and continue to earn a pre-tax target operating income of $1,200?" The CVP analysis works backwards, from the bottom to the top line of the contribution margin statement. Wei simply inserts all the values she knows. The targeted selling price per unit is $179.

Target operating income	$1,200
Add fixed costs	2,000
Target contribution margin	$3,200
Divided by number of units sold	÷ 50 units
Target contribution margin per unit	$ 64
Add variable cost per unit	115
Target selling price	$ 179

Proof:	Revenue, $179 per unit × 50 units	$8,950
	Variable costs, $115 per unit × 50 units	5,750
	Contribution margin	3,200
	Fixed costs	2,000
	Operating income	$1,200

Wei should examine the effects of other decisions, such as simultaneously increasing advertising costs and lowering sales prices. What effect would that have on operating income? After completing her analysis, Wei should choose the alternative with the highest operating income.

Margin of Safety and Risk

The **margin of safety** is the amount at which either expected or actual revenue exceeds breakeven revenue. Expressed in units, it is calculated as budgeted sales quantity Q minus the breakeven quantity (Q − BEP Q). If the result is zero, then there is no margin of safety. Wei can choose her margin of safety by changing predicted sales quantity. She can use the margin of safety to answer questions such as what the consequences are if revenues decrease below budget, and how far they can fall before the breakeven point is reached.

Assume that Wei has fixed costs of $2,000, a selling price of $200, and variable cost per unit of $120. The budgeted revenue is $8,000, budgeted sales volume is 40 units, and the budgeted operating income is $1,200. Wei has already calculated that 25 units is the breakeven point for this set of assumptions and breakeven revenue is $5,000 (= $200 per unit × 25 units). Wei can determine the margin of safety using the following relationship expressed in equation form:

$$\text{Margin of safety} = \frac{\text{Budgeted}}{\text{revenue}} - \frac{\text{Breakeven}}{\text{revenue}} = \$8,000 - \$5,000 = \$3,000$$

$$\frac{\text{Margin of}}{\text{safety (in units)}} = \frac{\text{Budgeted}}{\text{sales (units)}} - \frac{\text{Breakeven}}{\text{sales (units)}} = 40 - 25 = 15 \text{ units}$$

Sometimes margin of safety is expressed as a percentage, and once again the denominator is revenue:

$$\text{Margin of safety percentage} = \frac{\text{Margin of safety in dollars}}{\text{Budgeted (or actual) revenue}}$$

In our example, the margin of safety percentage is 37.5%(= $3,000 ÷ $8,000).

This result means revenue would have to decrease substantially, by 37.5%, to reach breakeven revenue. The high margin of safety gives Wei confidence that she is unlikely to suffer a loss. What if Wei had predicted a sales volume of 30 units? Then, budgeted revenue would be $6,000 and the margin of safety would be as follows:

$$\text{Budgeted revenue} - \text{Breakeven revenue} = \$6,000 - \$5,000 = \$1,000$$

$$\frac{\text{Margin of}}{\text{safety percentage}} = \frac{\text{Margin of safety in dollars}}{\text{Budgeted (or actual) revenue}} = \frac{\$1,000}{\$6,000} = 16.67\%$$

This result means that if revenue decreases by more than 16.67%, Wei would suffer a loss. A lower margin of safety increases the risk of a loss.

Wei has just performed a **sensitivity analysis**, which is a "what-if" technique that managers use to examine how an outcome will change if the original predicted data are not achieved or if an underlying assumption changes. In this case, it reveals how changes to budgeted revenue affect Wei's margin of safety. Sensitivity analysis is a simple approach to recognizing **risk**—the possibility that actual future results will differ from expected results. If Wei does not have the tolerance for this level of risk, she will prefer not to rent a booth at the convention. **Risk tolerance** is the risk of loss measured in percent that a person or team is willing to take. The lower the percentage, the lower the tolerance for risk.

Alternative Fixed- and Variable-Cost Structures

Computer Conventions has presented Wei with three booth rental options. Her first option is to rent the booth for the fixed amount of $2,000. Her second option is to pay a fixed amount of $800 and an additional $30 charge (15% of her $200 selling price per unit) for every unit she sells. Her third option is to pay a $50 charge (25% of her $200 selling price per unit) for every unit she sells. The third option does not have a fixed amount. Exhibit 3-4 graphically depicts the profit–volume relationship for each option. The lines represent the relationship between units sold and operating income. We are already familiar with Option 1; this is a fully fixed-cost contract. If Wei fails to sell a single unit, she still must pay $2,000 for the booth.

The line representing Option 2 shows fixed costs of $800 and a contribution margin per unit of $50 (= $200 − $120 − $30). The arithmetic indicates that at 16 units Wei will cover her fixed cost ($800 ÷ $50 = 16 units).

The line representing Option 3 has fixed costs of $0 and a contribution margin per unit of $30 (= $200 − $120 − $50). If Wei sells 0 units, it costs her nothing to rent the booth. The graph shows that under each contract, the breakeven point (BEP) is either 25, 16, or 0 units. You can read these values where each sloped line crosses the horizontal axis.

Wei's reaction to the different BEPs will depend on how much downside risk she is willing to accept. In the worst case, when she sells nothing, she could lose $2,000, $800, or nothing. The return or upside potential is that if she sells more than the BEP in Option 1, revenue from each unit sold above the BEP goes straight to operating income at the rate of $80 per unit. In Option 2 her BEP is lower, but so too is her upside potential. Revenue from each unit sold above the BEP goes to operating income at the rate of $50 per unit. In Option 3 her BEP is as

Exhibit 3-4 Profit–Volume Graph for Alternative Rent Contract Options for Do-All Software

BEP = Breakeven point
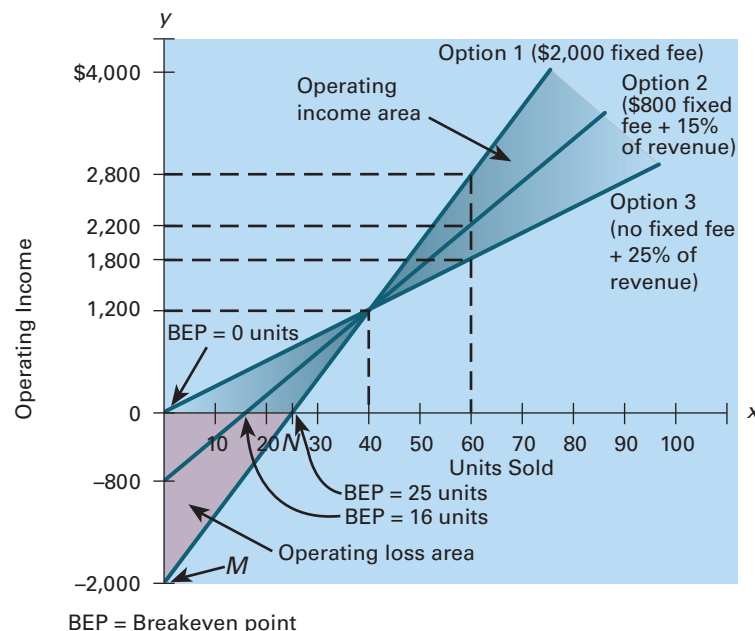
low as possible. Her upside potential, however, is only $30 per unit sold above that BEP. The risk–return trade-off across alternative cost structures can be measured as operating leverage.

Operating Leverage

Operating leverage describes the effects that fixed costs have on changes in operating income as changes occur in units sold and contribution margin. Organizations with a high proportion of fixed costs in their cost structures, as is the case under Option 1, have high operating leverage. The line representing Option 1 in Exhibit 3-4 is the steepest of the three lines. Small increases in sales lead to large increases in operating income; small decreases in sales result in relatively large decreases in operating income, leading to a greater risk of operating losses.

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

The following table shows the **degree of operating leverage** at sales of 40 units for the three alternative rent contracts:

	Option 1	Option 2	Option 3
1. Contribution margin per unit	$ 80	$ 50	$ 30
2. Contribution margin (Row 1 × 40 units)	3,200	2,000	1,200
3. Operating income (from Exhibit 3-4)	1,200	1,200	1,200

> **Note**
>
> Degree of operating leverage = $\dfrac{\text{Row 2}}{\text{Row 3}}$

$$\text{Degree of operating leverage} = \frac{\$3,200}{\$1,200} = 2.67 \qquad \frac{\$2,000}{\$1,200} = 1.67 \qquad \frac{\$1,200}{\$1,200} = 1.00$$

When sales are 40 units, a 1 percentage change in sales and contribution margin will result in 2.67 times that percentage change in operating income for Option 1. This is why the term *leverage* is used. Under Option 2, for example, the leverage decreases to 1.67 times any 1 percentage change in sales.

Consider, for example, a sales increase of 50% from 40 to 60 units. Contribution margin will increase by 50% under each alternative. However, operating income will increase from $1,200 to $2,800 [(= $1,200) + (2.67 × 50% × $1,200)] in Option 1. In Option 3 operating income will only increase from $1,200 to $1,800 [(= 1,200) + (1.00 × 50% × $1,200)]. The degree of operating leverage at a given level of sales helps managers calculate the effect of fluctuations in sales on operating income.

In general, whenever there are fixed costs, the degree of operating leverage decreases as the level of sales increases beyond the breakeven point. If fixed costs are $0, as in Option 3, contribution margin equals operating income and the degree of operating leverage equals 1.00 at all sales levels.

Cost structure is a long-term decision because fixed costs usually pay for capacity. Companies with a high percentage of fixed costs in their cost structure are often called **capital intensive companies**. Industries such as airlines, mobile communications, and gold mining are very capital intensive. When sales volume exceeds the breakeven point, each additional sale will contribute a large proportion of revenue to operating income. But when sales volumes fail to exceed breakeven, the debt associated with fixed costs must still be repaid, creating financial distress. For example, as the airline and car manufacturing industries accumulated losses from 2001 through 2007, many companies could not sell enough to cover fixed costs and declared bankruptcy.

Managers cannot avoid difficulties arising from a high fixed cost structure if their industry is capital intensive. High fixed cost simultaneously increases the risk of losses if demand is weak, and magnifies profit if demand is strong. A high fixed cost structure requires financing through either debt or equity. Debt carries a mandatory interest payment that shelters profit from tax only as long as there is a profit. If demand drops, the mandatory debt payments increase losses. This is why it is important to carefully evaluate how the level of fixed costs and variable costs will affect the risk–return trade-off.

Other companies may be labour intensive and reduce costs by transferring manufacturing facilities from Europe and North America to lower-cost countries such as Mexico and China. Companies may also substitute high fixed costs with lower variable costs

Concepts in Action | Sky-High Fixed Costs Trouble XM Satellite Radio

Nneirda/Shutterstock
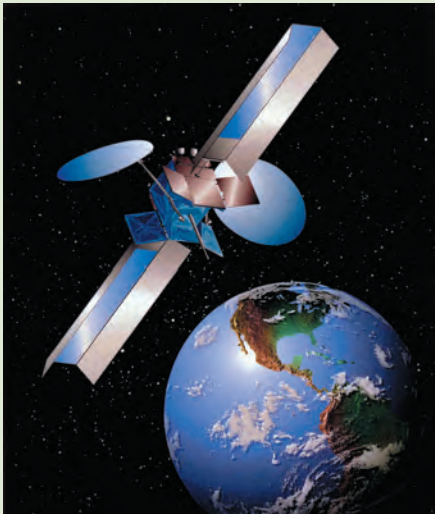
Fixed costs, unlike variable costs, do not automatically decrease as volume declines. XM Satellite Radio, once the market leader in satellite radio broadcasting, learned a hard lesson on the important effect of cost structure.

In 2001 the upfront costs for a broadcast licence, two space satellites, and other infrastructure was over $1 billion. Once in operation XM spent billions more on fixed costs to purchase content, satellite transmission space, and R&D. XM's variable costs were minimal, mainly artists' royalty fees, customer service, and billing. This business model had high operating leverage. XM's breakeven revenue comprised both fees from millions of subscribers and advertising revenue. The competitive disadvantage of this highly leveraged business model soon became apparent. By 2002 Sirius Satellite radio began business, competing head-to-head with XM. Other competitors included traditional free radio, which had a huge share of the market. Then the iPod entered the market.

For a fee, iPod users could customize their entertainment and endure no commercial interruptions at all. The cost structure around the iPod had much lower operating leverage. Apple's R&D and purchase of various applications and content provided service to any iMac, MacBook, iPhone, or iPod user. Any additional or marginal costs were primarily tied to manufacturing and distribution of the iPod. The breakeven sales volume for this product was far below that of any satellite radio station.

XM began spending extravagantly. They spent over $650 million for exclusive programming content, such as Major League Baseball and Oprah Winfrey. Sirius responded by inking an exclusive deal with the National Football League and paying "shock-jock" Howard Stern nearly $500 million to move to Sirius. This increased the operating leverage for both companies.

By 2006, despite its nearly 8 million subscribers, XM had never turned a profit and most analysts and observers felt that neither XM nor Sirius (with 6 million subscribers) would ever be able to recover their high fixed costs … and they were almost right. In 2007 XM merged with Sirius and the new CEO acknowledged that high operating leverage killed both companies and forced the merger. He vowed to look for "synergies on every line of the statement of comprehensive income."

Sources: "XM Satellite Radio (A)," Harvard Business School Case No. 9-504-009; "Satellite Radio: An Industry Case Study," Kellogg School of Management (Northwestern University) Case No. 5-206-255; Testimony of Sean Buston, CFA, before the Copyright Royalty Board of the Library of Congress (October 2006); Justin Fox, "The 'stop us before we spend again' merger," Time.com, February 20, 2007. time-blog.com/curious_capitalist/2007/02/the_stop_us_before_we_spend_ag.html; Various analysts reports.

when they purchase products from lower-cost suppliers instead of manufacturing products themselves. General Electric and Hewlett-Packard recently began offshoring service functions, such as post-sales customer service, to countries like India where costs are lower.

Decision Models and Uncertainty[2]

▶ **LO 5**

Analyze the implications of uncertainty on decision models.

Always distinguish between a good decision and a good outcome. One can exist without the other. Suppose you are offered a one-time-only gamble tossing a coin. You will win $20 if the outcome is heads, but you will lose $1 if the outcome is tails. As a decision maker, you proceed through the logical phases: gathering information, assessing outcomes, and making a choice. You accept the bet. Why? Because the expected value is $9.50 [= 0.5($20) + 0.5(− $1)]. The coin is tossed and the outcome is tails. You lose. From your viewpoint, this was a good decision but a bad outcome.

_____

[2] The presentation here draws (in part) from teaching notes prepared by R. Williamson.

A decision can be made only on the basis of information that is available at the time of evaluating and making the decision. By definition, uncertainty rules out guaranteeing that the best outcome will always be obtained. As in our example, it is possible that bad luck will produce bad outcomes even when good decisions have been made. A bad outcome does not mean a bad decision was made. The best protection against a bad outcome is a good decision.

Role of a Decision Model

It is important to understand the characteristics of uncertainty, so managers can adopt an approach to make decisions in a world of uncertainty. In the face of uncertainty—the possibility that an actual amount will deviate from an expected amount—managers rely on decision models to help them make the right choices. A decision model is a formal method for making a choice, commonly involving both quantitative and qualitative analyses.

Expected Value

The tool best suited to help Wei make a decision is a calculation of expected value. **Expected value** is the sum of the risk-weighted average of the outcomes of each choice. In this example the outcome is the operating income. Assume Wei can say she is 60% sure she will sell 30 units and 40% sure she will sell 60 units at the convention. The 60% and 40% are measures of risk or probability (p_i). The sales volumes are events. Her weighted sales are the most likely events, a combination of $0.60 \times 30 = 18$ units and $0.40 \times 60 = 24$ units respectively. The notation for 60% is $p_1 = (0.60)$; the notation for 40% is $p_2 = (0.40)$. The mathematical notation for the possible sales volumes are $Q_1 = 30$ and $Q_2 = 60$. The expected or risk-weighted sales volume is calculated as the sum of the risk-weighted volumes:
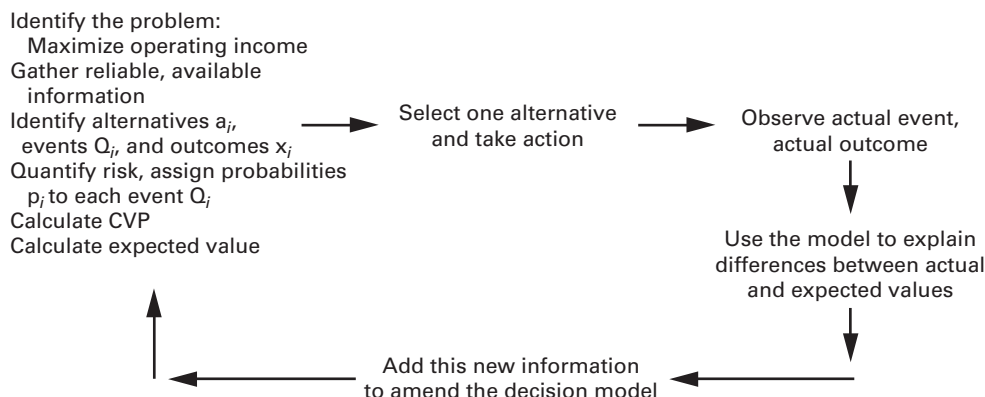
$$(p_1 \times Q_1) + (p_2 \times Q_2) = \text{Expected sales volume}$$

$$(0.6 \times 30) + (0.4 \times 60) = \text{Expected sales volume}$$

$$= 42 \text{ units}$$

Exhibit 3-5 illustrates how Wei can calculate her expected operating income using the expected sales volume of 42 units.

Exhibit 3-5 Decision Table for Do-All Software

Inputs			
Event, sales volume Q_i		30	60
Probability (p_i)		0.60	0.40
Expected sales volumes		18	24
Total expected sales volumes (p_1) $\times$ (Q_1) + (p_2) $\times$ (Q_2)	42		
Alternative contracts: fixed cost	$2,000	$ 800	$ —
Alternative contracts: total variable cost as a % of revenues	0%	15%	25%
CVP analysis	**Option a₁**	**Option a₂**	**Option a₃**
Sales price per unit	$ 200	$ 200	$ 200
Variable cost per unit (including rental)	120	150	170
Contribution margin	80	50	30
Expected value analysis			
Expected revenues ($200 $\times$ 42)	$8,400	$8,400	$8,400
Expected total variable cost	5,040	6,300	7,140
Expected contribution margin	3,360	2,100	1,260
Fixed cost	2,000	800	—
Expected operating income (outcome x_1, x_2, x_3)	$1,360	$1,300	$1,260

Identify the problem:
  Maximize operating income
Gather reliable, available
  information
Identify alternatives a_i,
  events Q_i, and outcomes x_i
Quantify risk, assign probabilities
  p_i to each event Q_i
Calculate CVP
Calculate expected value

→ Select one alternative
  and take action

→ Observe actual event,
  actual outcome

↓

Use the model to explain
differences between actual
and expected values

↓

Add this new information
to amend the decision model

↑

If Wei is **risk neutral**, she will simply look at the expected operating income under each alternative contract. *Risk neutral* means the decision maker will feel as much pain at losing a dollar as joy at gaining a dollar. Wei will simply select the highest expected operating income. This is Wei's rational choice.

Making a decision is not the end of business planning and control. If Wei makes the decision to attend the convention, she has done so on the basis of predicted outcomes. As a good manager, Wei will conclude by comparing her actual operating income to her expected operating income. Exhibit 3-6 illustrates how the decision framework applies to making a decision using expected values.

Effects of Sales Mix on Income

► **LO 6**

Interpret the results of CVP analysis in complex strategic, multi-product, and multiple cost driver situations.

Sales mix is the quantities of various products (or services) that in sum are the total sales volume of a company. Each product or service is a proportion of the total sales volume measured either as units or revenue.

Suppose Wei looks to the future and budgets the following for a conference in Toronto where she expects to sell different quantities of two products, Do-All Software and Superword:

	Do-All	Superword	Total
Expected sales	60	40	100
Revenue, $200 and $100 per unit	$12,000	$4,000	$16,000
Total variable costs ($120 × 60; $70 × 40)	7,200	2,800	10,000
Contribution margin ($80 × 60; $30 × 40)	$ 4,800	$1,200	6,000
Fixed costs			4,500
Operating income			$ 1,500

What is the BEP? The total sales volume to break even in a multi-product company depends on the sales mix—the combination of the number of units of Do-All sold and the number of units of Superword sold. We assume that the budgeted sales mix is 3:2 (60:40), because Wei expects to sell 3 (60 out of the 100) units of Do-All for every 2 (40 out of the 100) units she sells of Superword. To simplify her planning, Wei assumes this will not change at different quantities of each product sold. In fact, Wei is selling a bundle composed of three units of Do-All and two units of Superword. The two products are not physically bundled, but for planning purposes (budgeting), it is easier to work with a bundle of five units in total sales volume.

Each bundle yields a contribution margin of $300, calculated as follows:

	Sales Volume per Product in Each Bundle	Contribution Margin per Unit for Do-All and Superword	Contribution Margin of the Bundle
Do-All	3	$80	$240
Superword	2	30	60
Total			$300

With the contribution margin for each bundle, Wei can now calculate the breakeven sales volume in bundles:

$$\text{Breakeven sales volume in bundles} = \frac{\text{Fixed costs}}{\text{Contribution margin per bundle}} = \frac{\$4,500}{\$300 \text{ per bundle}} = 15 \text{ bundles}$$

The breakeven point for each product using the 3:2 ratio is calculated by multiplying the breakeven sales volume of bundles first by 3 for Do-All, then 2 for Superword:

Do-All: 15 bundles × 3 units of Do-All per bundle	45 units
Superword: 15 bundles × 2 units of Superword per bundle	30 units
Breakeven sales volume in units	75 units

Breakeven point in dollars for Do-All and Superword is:

Do-All: 45 units × $200 per unit	$ 9,000
Superword: 30 units × $100 per unit	3,000
Breakeven revenue	$12,000

We can also calculate the breakeven point in revenue for the multi-products situation as follows:

	Sales Volume in Each Bundle	Sales Price per Unit	Revenue of the Bundle
Do-All	3	$200	$600
Superword	2	100	200
Total			$800

$$\text{Contribution margin percentage for the bundle} = \frac{\text{Contribution margin of the bundle}}{\text{Revenue of the bundle}} = \frac{\$300}{\$800} = 0.375 \text{ or } 37.5\%$$

$$\text{Breakeven revenue} = \frac{\text{Fixed costs}}{\text{Contribution margin \% for the bundle}} = \frac{\$4,500}{0.375} = \$12,000$$

$$\text{Breakeven sales volume in bundles} = \frac{\text{Breakeven revenue}}{\text{Revenue per bundle}} = \frac{\$12,000}{\$800 \text{ per bundle}} = 15 \text{ bundles}$$

Of course, there are many different sales mixes (in units) that result in a contribution margin of $4,500 and cause Wei to break even, as the following table shows:

Sales Mix (Units)		Contribution Margin From		
Do-All (1)	Superword (2)	Do-All (3) = $80 × (1)	Superword (4) = $30 × (2)	Total Contribution Margin (5) = (3) + (4)
48	22	$3,840	$ 660	$4,500
36	54	2,880	1,620	4,500
30	70	2,400	2,100	4,500

If, for example, the sales mix changes to 3:7, or 3 units of Do-All for every 7 units of Superword, you can see in the preceding table that the breakeven sales volume in bundles increases from 75 units to 100 units. The breakeven quantity increases because the new sales mix shifted to the product with the lower contribution margin per unit ($30 rather than $80). Generally, if the problem is how to maximize operating income, Wei should

shift her sales mix to increase the sales volume of the higher contribution margin product. Companies adjust their sales mix to respond to demand changes. For example, as gasoline prices increase and customers want smaller cars, auto companies shift their production mix to produce additional smaller cars.

Multiple Cost Drivers

Throughout this chapter, we have assumed that the sales volume Q was exactly the same as the production (or acquisition) volume. This single volume was the only **revenue driver** and the only cost driver. A more complicated problem arises if this assumption is wrong. The CVP analysis can be adapted if there are multiple cost drivers. To simplify, we will examine the situation where there is a single product.

Suppose Wei will incur a variable cost of $10 for preparing documents (including an invoice) for each customer who buys Do-All Software. The cost driver of document-preparation costs is the number of customers who buy Do-All Software. Wei's operating income can then be expressed in terms of revenue and these costs:

$$\text{Operating income} = \text{Revenue} - \left(\begin{array}{c} \text{Variable} \\ \text{cost per} \\ \text{unit} \end{array} \times \begin{array}{c} \text{Quantity of} \\ \text{packages} \\ \text{sold} \end{array} \right) - \left(\begin{array}{c} \text{Variable cost} \\ \text{of documents} \\ \text{per customer} \end{array} \times \begin{array}{c} \text{Quantity of} \\ \text{customers} \end{array} \right) - \text{Fixed costs}$$

If Wei sells 40 units to 15 customers, then operating income is:

$$\text{Operating income} = (\$200 \text{ per unit} \times 40 \text{ units}) - (\$120 \text{ per unit} \times 40 \text{ units})$$

$$- (\$10 \text{ per customer} \times 15 \text{ customers}) - \$2,000$$

$$= \$8,000 - \$4,800 - \$150 - \$2,000 = \$1,050$$

If Wei sells 40 units to 40 customers, then operating income is:

$$\text{Operating income} = (\$200 \times 40) - (\$120 \times 40) - (\$10 \times 40) - \$2,000$$

$$= \$8,000 - \$4,800 - \$400 - \$2,000 = \$800$$

The number of packages sold is not the only factor that affects Wei's operating income. If sales volume is constant but the quantity of customers increases, then Wei's operating income will decrease. The costs depend on two cost drivers, both the sales volume and the number of customers.

CVP Analysis in Non-Profit and Public Sector Organizations

So far our CVP analysis has focused on a merchandising company. CVP can also be applied to manufacturing, service, non-profit, and public sector organizations. In fact, the key goal of a non-profit company is to break even, not to maximize profit. To apply CVP analysis in service and non-profit organizations we need to focus on measuring their output. Service and social welfare outputs are measured differently from products sold by manufacturing and merchandising companies. Examples of output measures in various service and non-profit industries are as follows:

Industry	Measure of Output
Airlines	Passenger miles
Hotels/motels	Room-nights occupied
Hospitals	Patient days
Universities	Student credit-hours
Professional associations	Number of memberships

Consider a community care agency that has government support of $900,000 (its revenues) for 2015. This non-profit agency's purpose is to assist differently abled people seeking employment. On average, the agency supplements each individual's annual

income by $5,000. The agency's only other costs are fixed costs of rent and administrative salaries equal to $270,000. The agency manager wants to know how many people can be assisted in 2015. We can use CVP analysis here by setting operating income to $0. Let Q be the number of differently abled people to be assisted:

$$\text{Revenue} - \text{Variable costs} - \text{Fixed costs} = \$0$$
$$\$900,000 - \$5,000\,Q - \$270,000 = \$0$$
$$\$5,000\,Q = \$900,000 - \$270,000 = \$630,000$$
$$Q = \$630,000 \div \$5,000 \text{ per person} = 126 \text{ people}$$

Suppose the manager is concerned that the total budget appropriation for 2015 will be reduced by 15% to $765,000 ($900,000 × (1 − 0.15) = $765,000). How many people could be assisted (with $5,000) on this reduced budget?

$$\$765,000 - \$5,000\,Q - \$270,000 = \$0$$
$$\$5,000\,Q = \$765,000 - \$270,000 = \$495,000$$
$$Q = \$495,000 \div \$5,000 \text{ per person} = 99 \text{ people}$$

Note the following two characteristics of the CVP relationships in this non-profit situation:

1. The percentage drop in the number of people assisted, (126 − 99) ÷ 126, or 21.4%, exceeds the 15% reduction in the budget. The reason is that the $270,000 in fixed costs must still be paid. In a lower total budget, less money remains to assist people. The percentage drop in service exceeds the percentage drop in budgeted revenue from the government.

2. Given the reduced revenue of $765,000, the manager can adjust operations to stay within this appropriation in at least one of three basic ways: (a) reduce the number of people assisted from the current 126, (b) reduce the variable cost of assistance from $5,000 per person, or (c) reduce the total fixed costs from the current $270,000.

Pulling It All Together—Problem for Self-Study

(Try to solve this problem before examining the solution that follows.)

Problem

The following problem illustrates how to use relevant information from both the financial accounting statement of comprehensive income and the contribution statement of comprehensive income to calculate the breakeven point. Wei wants to know how to calculate her breakeven sales volume and her breakeven sales revenue. (R. Lambert, adapted)

Wei has gathered the following information: Operating income for Wei Shao Inc. (WSI) for the year 2015 on production and sales volume (Q) of 200,000 units was summarized in the financial accounting operating statement of comprehensive income below. Additional accounting information was also provided regarding the inventoriable fixed costs and the period (non-manufacturing, operating expenses) variable costs per unit shown below the operating income:

Wei Shao Inc. Operating Statement of Comprehensive Income Year Ended 2015	
Sales revenue	$3,120,000
Cost of goods sold (COGS)	1,920,000
Gross margin	1,200,000
Operating expenses	1,380,000
Operating income (loss)	$ (180,000)
Fixed cost (inventoriable)	$ 600,000
Variable cost per unit (non-manufacturing)	$ 6.00

Required ▶ ❶❷
❶❷
❷

1. Calculate WSI's variable manufacturing costs per unit in 2015.
2. Calculate WSI's fixed marketing and distribution costs in 2015.
3. Because WSI's gross margin per unit is $6 (= $1,200,000 ÷ 200,000 units), Wei believes that if WSI had produced and sold 230,000 units, it would have covered the $1,380,000 of marketing and distribution costs ($1,380,000 ÷ $6 = 230,000) and enabled WSI to break even for the year. Calculate WSI's operating income if production and sales volume had been $Q = 230,000$ units. Explain briefly why Wei is wrong.

❶
❸

4. Calculate the breakeven point for the year 2015 in both sales volume and revenue.
5. Calculate both the sales volume required to achieve operating income of $100,000 and the operating profit margin percentage.

❹

6. Calculate total fixed and total variable cost as a proportion of total cost. What is Wei's cost structure and her risk/return tradeoff?

❸❹

7. Wei has been following market demand closely and believes there is a 35% probability that sales volume will be 300,000 units in 2015, a 25% probability that sales volume will be 320,000 units, and a 40% probability that sales volume will be 280,000 units. Calculate the risk-weighted expected sales volume in 2015. Can Wei expect to earn her targeted operating income calculated in requirement 5?

❹

8. Calculate Wei's margin of safety in dollars and percentage. How does adding risk as a factor improve Wei's CVP analysis?

❹

9. If Wei had to pay an additional variable cost of $5 per customer order, calculate her best alternative to maximize operating income. Alternative 1 is to sell 297,000 units to 15,000 customers. Alternative 2 is to sell 293,334 units to 9,500 customers.

Solution

1. Calculate unit variable cost (inventoriable)

Total inventoriable costs (COGS)		$1,920,000
Fixed cost (inventoriable)		600,000
Total variable cost (inventoriable) = COGS − Fixed cost inventoriable		$1,320,000
Q produced and sold	200,000	
Variable cost per unit (inventoriable) = Total variable cost ÷ Q =		$ 6.60

2. Calculate fixed cost (period or non-manufacturing operating expenses)

Total operating expenses	$1,380,000
Total variable cost (Variable cost per unit × Q) = $6.00 × 200,000	1,200,000
Fixed cost (Operating expenses – Total variable non-manufacturing cost) =	$ 180,000

3. Calculate operating income

Sales price per unit for Q produced and sold = Revenue ÷ Q	200,000	$ 15.60
Contribution margin per unit × (Sales price per unit – Total variable cost per unit)		$ 3.00
Revenue for Q produced and sold =	230,000	$3,588,000
Contribution margin for total Q produced and sold =		690,000
Total fixed cost (inventoriable and non-manufacturing)		780,000
Operating income (Contribution margin – Total fixed cost)		$ (90,000)

Wei has confused gross with total contribution margin. She assumed that the COGS comprised only variable costs and that non-manufacturing costs comprised only fixed costs. Wei does not distinguish that cost behaviour is independent of cost classification. Both manufacturing and non-manufacturing costs comprise both fixed and variable costs.

4. Calculate breakeven point in sales volume Q and revenue

Breakeven point, $Q =$ (FC ÷ Contribution margin per unit $= \$780,000 ÷ \$3.00$)

$= 260,000$

Breakeven point, Revenue = (Breakeven volume $Q \times$ Contribution margin per unit)

$= \$4,056,000$

Alternatively use CM% = Contribution margin per unit ÷ Sales price per unit)

$= 19.231\%^*$

Breakeven point, Revenue = (Fixed cost ÷ CM% or $\$3,120,000 ÷ 0.19231$)

$= \$4,056,000^*$

*Exactly this percentage can also be obtained from Contribution margin ÷ Revenue using amounts from requirement 3.

5. Calculate a target operating income

Contribution margin per unit	$ 3.00
Target operating income	$ 100,000
Fixed costs	$ 780,000
$\text{Sales volume} = \dfrac{(\text{Fixed costs} + \text{Target operating income})}{\text{Contribution margin per unit}} =$	293,333.3*
Revenue	$4,576,011 (rounded)
Operating profit margin percentage	2.2%

Note that Wei cannot make $^1/_3$ of a sale therefore her targeted sales volume must be rounded up to 293,334.0.

6. Calculate total fixed and total variable costs as a proportion of total costs

	Cost	%
Total fixed costs	$ 780,000	23.6
Total variable costs	2,520,000	76.4
Total costs	$ 3,300,000	

7. Calculate the risk-weighted expected sales volume in 2016.

	Q	Probability	Risk Weighted
Sales volume 1	300,000	0.35	105,000
Sales volume 2	320,000	0.25	80,000
Sales volume 3	280,000	0.40	112,000
Risk-weighted total expected sales volume			297,000

Including risk as a quantitative factor makes it clear to Wei and others if she has a biased view of future demand. Should Wei choose to explain her assumptions, it would be very easy. She can also readily show very pessimistic and very optimistic "what if" expected sales volumes. Based on this model, Wei can also calculate her margin of safety relative to her expected sales volume.

Wei can expect to achieve her targeted operating income of $100,000 because the expected sales volume exceeds the sales volume required to achieve her target.

8. Calculate the margin of safety in dollars and % using the expected operating income.

	Expected	Breakeven	Margin of Safety
Margin of safety = Budgeted (expected revenue) = Breakeven revenue	$4,633,200	$4,056,000	$577,200
Margin of safety percentage = Margin of safety ÷ Expected revenue			12.46%

9. Calculate the alternative with the highest operating income.

	Q = Quantity	Sales price	Variable cost		Fixed costs	Operating income
Alternative 1						
Sales in units	297,000	$ 15.60	$ 12.60			
Sales to customers	15,000		5.00			
Totals:			$3,817,200	$4,633,200	$780,000	$ 36,000
Alternative 2						
Sales in units	293,334	$ 15.60	$ 12.60			
Sales to customers	9,500		5.00			
Totals:			$3,743,508	$4,576,011	$780,000	$ 52,502

Wei's operating income is higher under alternative 2 and this is the alternative she would prefer. She has 2 cost drivers but only 1 revenue driver. The fewer customer orders, the lower is her total variable cost. Her operating leverage is low and so too is her contribution margin. This information can help Wei market her product to increase the Q or increase the quantity of units per customer order, rather than just focus on increasing Q.

Summary Points

The following question-and-answer format summarizes the chapter's learning objectives. Each point presents a key question, and the guidelines are the answer to that question.

Learning Objectives	Guidelines
1. How can CVP analysis assist managers?	CVP analysis requires managers to distinguish cost behaviour from cost classification in an accurate model of relationships among factors critical to maximize profit. While an statement of comprehensive income provides reliable information, managers use a different contribution margin format for CVP models. The values of relevant cost, volume, and profit factors change among alternatives.
2. How do managers determine the breakeven point or the output needed to achieve a target operating income?	These two analyses differ with respect to one factor: the value assigned to operating income. At the breakeven point, the target operating income = $0. Any target operating income > $0 requires a sales volume higher than the breakeven point.
3. How should companies incorporate income taxes into CVP analysis?	Income taxes can be incorporated into CVP analysis by using target net income rather than target operating income. The breakeven point is unaffected by income taxes because no income taxes are paid when operating income = $0.
4. How should companies cope with risk, to explain how cost structure affects decisions?	Expected value uses probability to make the effect of failure on operating income clear. The decision among alternatives requires understanding how cost structure affects both the downside risk and the upside potential effects on operating income.
5. What are the implications of uncertainty on decision models?	Most important decisions are often complex in nature and involve multiple stakeholders, contributing to a high degree of uncertainty. Methodical approaches need to be adopted to collect and analyze data, develop the best answer, and avoid unintended consequences.
6. How can CVP analysis be applied to a company producing multiple products (revenue drivers) and multiple cost drivers?	CVP analysis can be applied to a company producing multiple products by assuming the sales mix of products sold remains constant as the total quantity of units sold changes. The basic concepts of CVP analysis can be applied to multiple cost driver situations, but there is no unique breakeven point.

Terms to Learn

This chapter and the Glossary at the end of the book contain definitions of the following important terms:

breakeven point (BEP) **(p. 58)**
capital intensive companies **(p. 69)**
contribution statement of comprehen-
  sive income **(p. 60)**
contribution margin **(p. 63)**
contribution margin percentage
  (p. 63)
contribution margin per unit **(p. 60)**
contribution margin ratio **(p. 63)**

cost–volume–profit (CVP) analysis
  (p. 58)
degree of operating leverage
  (p. 69)
expected value **(p. 71)**
gross margin **(p. 64)**
gross margin percentage **(p. 64)**
margin of safety **(p. 67)**
net income margin **(p. 64)**

net income margin percentage **(p. 64)**
operating leverage **(p. 69)**
operating margin **(p. 64)**
revenue driver **(p. 74)**
risk **(p. 68)**
risk neutral **(p. 72)**
risk tolerance **(p. 68)**
sales mix **(p. 72)**
sensitivity analysis **(p. 68)**

Assignment Material

MyAccountingLab   The questions, exercises, and problems marked in red can be found
on MyAccountingLab. You can practice them as often as you want, and most feature step-by-step guided
instructions to help you find the right answers. Exercises and Problems with an Excel icon in the margin
have an accompanying Excel template on MyAccountingLab.

Short-Answer Questions

3-1 Describe the assumptions underlying CVP analysis.

3-2 Distinguish between operating income and net income.

3-3 "CVP is both simple and simplistic. If you want realistic analysis to underpin your decisions, look
beyond CVP." Do you agree? Explain.

3-4 How does an increase in the income tax rate affect the breakeven point?

3-5 Describe sensitivity analysis. How has spreadsheet software affected its use?

3-6 Give an example of how a manager can decrease variable costs while increasing fixed costs.

3-7 Give an example of how a manager can increase variable costs while decreasing fixed costs.

3-8 What is operating leverage? How is knowing the degree of operating leverage (DOL) helpful to
managers?

3-9 How can a company with multiple products compute its breakeven point?

Exercises

3-10 **Terminology.** A number of terms are listed below:

contribution margin   cost–volume–profit analysis
capital intensive   operating leverage
gross margin   sales mix
contribution margin percentage   breakeven point
margin of safety

Required

Select the terms from the above list to complete the following sentences (use each term only once).

1. A term for a company with a high percentage of fixed costs in its cost structure is _____.
2. _____ is a model to analyze the behaviour of net income in response to change in total
revenues, total costs, or both.
3. The _____ in units is the quantity of units sold to attain an operating income of zero.

4. _____ describes the effects that fixed costs have on changes in operating income as changes occur in units sold and contribution margin.
5. The _____ is equal to revenue less variable costs.
6. The _____ equals the contribution margin per unit divided by the selling price per unit.
7. The _____ equals revenues less cost of goods sold.
8. The _____ is the quantities of various products (or services) that in sum are the total sales volume of a company.
9. The _____ is the amount by which expected (or actual) revenues exceed breakeven revenues.

3-11 **CVP analysis computations.** The following partial information is available. Complete the table by filling in all the blanks. Each case is independent.

Case	Revenues	Variable Costs	Fixed Costs	Total Costs	Operating Income	Contributing Margin Percentage
a	$ 4,000	$____	$ 500	$____	$1,460	___%
b	_____	7,400	_____	8,700	9,800	___
c	10,600	_____	3,200	_____	_____	30
d	9,450	_____	2,500	8,170	_____	___

3-12 **CVP analysis computations.** Fill in the blanks for each of the following independent cases.

Case	Unit Selling Price	Unit Variable Operating Costs	Number of Units Sold	Total Contribution Margin	Total Fixed Costs	Operating Income
a	$ 70	$25	$_____	$ 900,000	$_____	$200,000
b	___	62	15,000	_____	250,000	125,000
c	250	___	30,000	4,500,000	_____	900,000
d	150	___	24,000	1,728,000	1,500,000	_____

3-13 CVP computations. Patel Manufacturing sold 200,000 units of its product for $30 per unit. Variable cost per unit is $25 and total fixed costs are $800,000.

Required

1. Calculate (a) contribution margin and (b) operating income.
2. Patel's current manufacturing process is labour intensive. Kate Schoenen, Patel's production manager, has proposed investing in state-of-the-art manufacturing equipment, which will increase the annual fixed costs to $2,400,000. The variable costs are expected to decrease to $16 per unit. Patel expects to maintain the same sales volume and selling price next year. How would acceptance of Schoenen's proposal affect your answers to (a) and (b) in requirement 1?
3. Should Patel accept Schoenen's proposal? Explain.

3-14 **CVP analysis, income taxes.** Diego Motors is a small car dealership. On average it sells a car for $26,000, which it purchases from the manufacturer for $22,000. Each month, Diego Motors pays $60,000 in rent and utilities and $70,000 for salespeople's salaries. In addition to their salaries, salespeople are paid a commission of $500 for each car they sell. Diego Motors also spends $10,000 each month for local advertisements. Its tax rate is 40%.

Required

1. How many cars must Diego Motors sell each month to break even?
2. Diego Motors has a target monthly net income of $63,000. What is its target operating income? How many cars must be sold each month to reach the target monthly net income of $63,000?

3-15 **CVP analysis, income taxes.** Orillia Equipment sells riding lawn mowers. The average price for a lawn mower is $16,000. Orillia purchases these mowers from the manufacturers at an average cost of $12,200. Orillia's monthly fixed costs are $28,000 in rent, $45,000 in salaries, $5,600 in advertising and promotion, and $1,200 in other operating expenses. It has a corporate tax rate of 25%.

Required

1. How many mowers must Orillia Equipment sell each month to break even?
2. How many mowers must be sold each month if Orillia Equipment has a target net income of $75,000?

3-16 **CVP analysis, income taxes.** The Rapid Meal has two restaurants that are open 24 hours a day. Fixed costs for the two restaurants together total $450,000 per year. Service varies from a cup of coffee to full meals. The average sales bill per customer is $8.00. The average cost of food and other variable costs for each customer is $3.20. The income tax rate is 30%. Target net income is $105,000.

Required

1. Compute the revenue needed to earn the target net income.
2. How many customers are needed to earn net income of $105,000? How many customers are needed to break even?
3. Compute net income if the number of customers is 150,000.

3-17 **Gross margin and contribution margin.** The National Symphony is preparing for its annual appreciation dinner for contributing members. Last year, 500 members attended the dinner. Tickets for the dinner were $20 per attendee. Last year's statement of comprehensive income was as follows:

Ticket sales	$10,000
Cost of dinner	11,000
Gross margin	(1,000)
Invitations and paperwork	3,000
Profit (loss)	$ (4,000)

This year the dinner committee does not want to lose money on the dinner. To help achieve its goal, the committee analyzed last year's costs. Of the $11,000 total cost of the dinner, it was determined that $6,000 were fixed costs and $5,000 were variable costs. Of the $3,000 for invitations and paperwork, $2,500 were fixed and $500 were variable.

Required

1. Prepare last year's profit report using the contribution-margin format.
2. The committee is considering expanding this year's dinner invitation to include volunteer members (in addition to contributing members). If the committee expects attendance to double, calculate the effect this will have on the profitability of the dinner.

3-18 **Athletic scholarships, CVP analysis.** Huron University is committed to improving access to higher education. Each year it makes $4,500,000 available for scholarships for students based on financial needs and academic achievement. The scholarship covers the full annual tuition (based on a full course load) for the recipients. Tuition fees are based on credit hours ($400 per credit hour), and a full-time student takes 30 credit hours per year. Fixed costs of administering the scholarship program are $600,000 per year.

Required

1. How many athletic scholarships can Huron University offer each year?
2. Suppose the total budget for the following year is reduced by 20%. Fixed costs are to remain the same. Calculate the number of scholarships that Huron can offer in the following year.
3. As in requirement 2, assume a budget reduction of 20%. Fixed costs are to remain the same. If Huron wanted to offer the same number of scholarships as it did in requirement 1, how much reduction in tuition would it be able to offer to each student who receives a scholarship?

3-19 **CVP analysis, changing revenues and costs.** Sunshine Tours is a travel agency specializing in cruises between Miami and Jamaica. It books passengers on Carib Cruises. Sunshine's fixed costs are $22,000 per month. Carib charges passengers $1,000 per round trip ticket.

Required

Calculate the number of tickets Sunshine must sell each month to (a) break even and (b) make a target operating income of $10,000 per month in each of the following independent cases.

1. Sunshine's variable costs are $35 per ticket and Carib Cruises pays Sunshine 8% commission on the ticket price.
2. Sunshine's variable costs are $29 per ticket. Carib Cruises pays Sunshine 8% commission on the ticket price.

3. Sunshine's variable costs are $29 per ticket. It receives a $48 commission per ticket from Carib Cruises. Comment on the results.

4. Sunshine's variable costs are $29 per ticket. It receives a $48 commission per ticket from Carib Cruises. It charges customers a delivery fee of $12 per ticket. The cost for Sunshine to deliver the ticket is $2 per ticket. Comment on the result.

LO 2 ▶
2. CM%, 40%

3-20 Contribution margin, gross margin, and margin of safety. Mirabel Cosmetics manufactures and sells a face cream to small family-run stores in the greater Montreal area. It presents the monthly operating statement of comprehensive income shown here to François Laval, a potential investor in the business. Help Laval understand Mirabel's cost structure.

<div align="center">

Mirabel Cosmetics
Operating Statement of Comprehensive Income
for the Month of June 2016

</div>

Units sold		10,000
Revenue		$100,000
Cost of goods sold		
Variable manufacturing costs	$55,000	
Fixed manufacturing costs	20,000	
Total		75,000
Gross margin		25,000
Operating costs		
Variable marketing costs	5,000	
Fixed marketing and administration costs	10,000	
Total operating costs		15,000
Operating income		$ 10,000

Required

1. Recast the statement of comprehensive income to emphasize contribution margin.
2. Calculate the contribution margin percentage and breakeven point in units and revenues for June 2016.
3. What is the margin of safety (in units) for June 2016?
4. If sales in June were only 8,000 units and Mirabel's tax rate is 30%, calculate its net income.

LO 2 ▶
1. a. Operating income,
$120,000

3-21 CVP computations. The Chorus Company manufactures and sells pens. Present sales output is 5,000,000 units per year at a selling price of $0.60 per unit. Fixed costs are $1,080,000 per year. Variable costs are $0.36 per unit.

Required

(Consider each case separately.)

1. **a.** What is the present operating income for a year?
   b. What is the present breakeven point in revenue?
2. Compute the new operating income for each of the following independent changes:

   a. A $0.048 per unit increase in variable costs.
   b. A 10% increase in fixed costs and a 10% increase in units sold.
   c. A 20% decrease in fixed costs, a 20% decrease in selling price, a 10% decrease in variable costs per unit, and a 40% increase in units sold.
3. Compute the new breakeven point in units for each of the following changes:

   a. A 10% increase in fixed costs.
   b. A 10% increase in selling price and a $24,000 increase in fixed costs.

LO 4 ▶
1. Budgeted OI, $825,200

3-22 CVP exercises. Beans Unlimited sells specialty coffees in 1-kilogram packages. Fixed costs are budgeted at $730,000 per year. For the upcoming year, revenues are forecasted to be $3,240,000 (selling price is $36 per kilogram) and the company has an average contribution margin percentage of 48%.

Required

1. What is the budgeted operating income given the sales forecast?
2. Beans is considering reducing its fixed costs by 15%. This would result in a lowering of the contribution margin percentage to 42%. What would be the new forecasted operating income?
3. Another alternative Beans is considering is raising its selling price by 10%. It estimates this would result in a reduction in sales volume of 5%. There would be no changes to variable or fixed costs. What

would be the forecasted operating income with the new selling price and volume? What is the new contribution margin percentage?

4. Which strategy would you recommend for the company? Explain.

3-23 Operating leverage. Charles Rothman is an importer of silver cuff bracelets from Mexico. He has a three-month agreement with the local coffee shop, Dellano's, to set up a booth to exhibit the jewellery. Rothman is under no obligation to keep any unsold items and can return them to the Mexican silversmith at no personal cost. The average selling price of the bracelets is $125 and it costs Rothman $80 to purchase each piece. Dellano's has proposed two payment alternatives for the use of space.

■ Option 1: A fixed payment of $435 per month.

■ Option 2: 12% of the total revenues earned during the agreement.

Required

1. Calculate the breakeven point in units for (a) option 1 and (b) option 2.

2. At what level of sales revenue will Rothman earn the same operating income under either option?

3. a. For what range of unit sales will Rothman prefer option 1?
   b. For what range of unit sales will Rothman prefer option 2?

4. Calculate the degree of operating leverage at sales of 150 units for the two alternative rental options.

5. Briefly explain and interpret your answer in requirement 4.

3-24 Gross margin and contribution margin, making decisions. Saunders' Electronics had the following results for the year just ended:

Revenues		$800,000
Cost of goods sold (48% of sales)		384,000
Gross margin		416,000
Operating costs		
Salaries fixed	$212,000	
Sales commissions (12% of sales)	96,000	
Depreciation of equipment and fixtures	19,200	
Store rent ($5,100 per month)	61,200	
Other operating costs	72,300	460,700
Operating income (loss)		$ (44,700)

Jeff Saunders, the owner of the store, is unhappy with the operating results. An analysis of other operating costs reveals that it includes $36,000 variable costs, for which the cost driver is sales volume, and $40,300 fixed costs.

Required

1. Compute the contribution margin of Saunders' Electronics.

2. Compute the contribution margin percentage for the company.

3. Saunders estimates he can increase revenues by 25% by incurring additional advertising costs of $24,300. Calculate the impact on operating income of this action.

3-25 CVP, revenue mix. Durdon Snowboards sells two models of snowboards: the Men's Dominator and the Ladies' Luxury. Information on the two models of snowboards follows:

Product	Unit Selling Price	Unit Variable Cost	Sales Commission
Dominator	$750	$475	$25
Luxury	$640	$390	$21

Of Durdon's total sales, 70% are for the Men's Dominator model. The company's annual fixed costs are $180,000.

Required

1. Compute the unit contribution margin for each model of snowboard.

2. Compute the weighted-average contribution margin assuming a constant sales mix.

3. If the company's target operating income is $115,000, how many units of each model of snowboard must be sold to achieve the company's goals?

3-26 **CVP, international cost structure differences.** Thomas Inc. is considering three countries for the sole manufacturing site of its new product: India, China, and Canada. The product will be sold to retail outlets in Canada at $47.50 per unit. These retail outlets add their own markup when selling to final customers. The three countries differ in their fixed costs and variable costs per product.

	Annual Fixed Costs	Variable Manufacturing Costs per Unit	Variable Marketing and Distribution Costs per Unit
India	$ 6.4 million	$ 5.20	$21.80
China	4.4 million	9.50	18.40
Canada	10.2 million	19.30	6.20

Required

1. Compute the breakeven point of Thomas Inc. in both (a) units sold and (b) revenues for each of the three countries considered.
2. If Thomas Inc. sells 1,350,000 units in 2016, what is the budgeted operating income for each of the three countries considered?
3. What level of sales (in units) would be required to produce the same operating income in China and in Canada? What would be the operating income in India at that volume of sales?

3-27 **CVP, not for profit.** The Sunrise Group (SG) is an environmentally conscious organization that buys land with the objective of preserving the natural environment. SG receives private contributions and takes no assistance from the government. Fixed costs of operating the organization are $1,000,000 per year. Variable costs of purchasing the land (including environmental impact reports, title searches, etc.) average $3,000 per hectare. For the next budget year, SG expects to receive private contributions totalling $19,000,000. All contributions in excess of costs will be used to purchase land.

Required

1. How many hectares will SG be able to purchase next year?
2. SG is considering participating in a new government program that will provide $1,000 per hectare to subsidize the purchase of environmentally sensitive land. If SG participates in this program, it estimates the organization will lose $5,000,000 in contributions from supporters who believe that accepting money from the government is not consistent with its mission. If SG does participate in the program, and its forecasts are accurate, how many hectares of land will it be able to purchase? On financial considerations alone, should SG participate in the government program?
3. SG is worried that contributions may decrease by more than the $5,000,000 it has estimated if it takes the subsidy. By how much can contributions decrease for SG to be able to buy the same amount of land if it takes the government subsidy or rejects it? (i.e., what is the point of indifference between the two options?)

3-28 **CVP, revenue mix.** Zyrcon Ltd. is a computer games manufacturer. It currently has two games on the market: Alien Predators and Vegas Pokermatch. Data regarding the two products are as follows:

	Alien Predators	Vegas Pokermatch
Selling price	$89	$59
Variable manufacturing costs	18	12
Variable marketing costs	27	16

The fixed costs of Zyrcon are $18,750,000, and the current sales mix is 40% Alien Predators and 60% Vegas Pokermatch.

Required

1. Assuming no change in sales mix, costs, or revenues, what is the breakeven point in total units? How many units of Alien Predators and how many units of Vegas Pokermatch are sold at the breakeven point?
2. Assume the following sales mix: 20% Alien Predators and 80% Vegas Pokermatch. Calculate the breakeven point under this sales mix assumption.

3. For the two possible sales mixes (in requirements 1 and 2), determine operating income if total unit sales are 750,000.

3-29 Alternative cost structures, uncertainty, and sensitivity analysis. Edible Bouquets (EB) makes and sells flower bouquets. EB is considering opening a new store in the local mall. The mall has several empty shops and EB is unsure of the demand for its product. The mall has offered EB two alternative rental agreements. The first is a standard fixed-rent agreement where EB will pay the mall $5,000 per month. The second is a royalty agreement where the mall receives $10 for each bouquet sold. EB estimates that a bouquet will sell for $50 and have a variable cost of $30 to make (including the cost of the flowers and commission for the salesperson).

Required

1. What is the breakeven point in units under each assumption?
2. For what range of sales levels will EB prefer (a) the fixed-rent agreement and (b) the royalty agreement?
3. If EB signs a sales agreement with a local flower stand, it will save $5 in variable costs per bouquet. How would this affect your answer in requirement 2?
4. EB estimates that the store is equally likely to sell 200, 400, 600, 800, or 1,000 arrangements. Using information from the original problem, prepare a table that shows the expected profit at each sales level under each rental agreement. What is the expected value of each rental agreement? Which rental agreement should EB choose?

3-30 CVP analysis, multiple cost drivers. Clarke Ltd. is a manufacturer of promotional items. The majority of its revenues is from the production of promotional pens. Clarke imports these pens from China and then imprints them with corporate names. These pens are then distributed to customers, suppliers, etc., for promotional purposes. The pens are purchased in batches of 100 and each batch costs Clarke $95. Imprinting costs $0.35 per pen. Fixed costs average $275,000 per year. In addition to the variable imprint costs per pen; Clarke incurs additional variable costs per **customer** regardless of how many pens they may order. The variable cost per customer is $120. The selling price is $4.50 per pen. Clarke requires a minimum order of 50 pens and typically sells to customers in batches of 50, 100, 250, or 500 units.

Required

1. Assuming that Clarke anticipates it will sell 350,000 pens during the year and that the average order size will be 100 pens, calculate Clarke's operating income and operating margin.
2. Calculate Clarke's operating income and operating margin assuming it will sell 350,000 pens, but that the average order size will be 250 pens.
3. Calculate the breakeven points (in terms of number of orders) assuming the various batch sizes of 50, 100, 250, and 500 units.

3-31 Uncertainty. Angela King is the Las Vegas promoter for professional fighter Randy Couture. King is promoting a new Octagon world championship fight for Couture. The key area of uncertainty is the size of the cable pay-per-view TV market. King will pay Couture a fixed fee of $3.2 million and 25% of net cable pay-per-view revenue. Every cable TV home receiving the event pays $45, of which King receives $27. King pays Couture $6.75, 25% of the $27.

King estimates the following probability distribution for homes purchasing the pay-per-view event:

Demand	Probability
250,000	0.10
300,000	0.10
350,000	0.20
400,000	0.40
500,000	0.10
1,000,000	0.10

Required

1. What is the expected value of the payment King will make to Couture?
2. Assume the only uncertainty is over cable TV demand for the fight. King wants to know the breakeven point given her own fixed costs of $1.3 million and her own variable costs of $2.25 per home. (Also include King's payments to Couture in your answer.)

Problems

3-32 Effects on operating income, pricing decision. Tilda Manufacturing is a manufacturer of electronics components. Income data for one of the products (XT-107) for the month just ended are as follows:

Sales, 220,000 units at average price of $125		$27,500,000
Variable costs:		
Direct materials at $48 per unit	$10,560,000	
Direct manufacturing labour at $16 per unit	3,520,000	
Variable manufacturing overhead at $8 per unit	1,760,000	
Sales commissions at 12% of sales	3,300,000	
Other variable costs at $7 per unit	1,540,000	
Total variable costs		20,680,000
Contribution margin		6,820,000
Fixed costs		4,620,000
Operating income		$ 2,200,000

Tilda has capacity to produce 250,000 units each month, and its current average sales level is 175,000 units per month.

Recently Andrews Ltd. approached one of Tilda's sales representatives and asked if Tilda could supply a one-time order of 5,000 units of the XT-107. Its current supplier is moving to a new factory and has temporarily suspended production. Andrews has offered a selling price of $98 per unit. Sales commissions on this order can be negotiated at a flat fee of $9,500, instead of the normal 12% of sales. All other costs would behave as with regular production.

Required

1. From a financial perspective, should Tilda accept the order? (Calculate the change in monthly operating income if the order is accepted.)
2. The general manager of Tilda is concerned about accepting the order at the $98 selling price. He is afraid of the precedent that might be set by cutting the price and that Andrews might expect the same price concessions in the future. He has stated that he believes the sales representative should quote the regular price of $125 and argues that the $98 is below the full cost (excluding the commission) of $100 per unit. Do you agree with the general manager? Explain.

3-33 CVP, executive teaching compensation. David Hutchinson is an internationally known Canadian professor specializing in consumer marketing. In 2015, Hutchinson and United Kingdom Business School (UKBS) agreed to conduct a one-day seminar at UKBS for marketing executives. Each executive would pay $350 to attend. The non–speaker-related fixed costs for UKBS conducting the seminar would be:

Advertising in magazines	$5,200
Mailing of brochures	2,500
Administrative labour at UKBS	3,700
Charge for UKBS lecture auditorium	1,800

The variable costs to UKBS for each participant attending the seminar would be

Food service	$38
Printed materials and binders	37

The dean at UKBS initially offered Hutchinson its regular compensation package of (a) business-class airfare and accommodation ($3,800 maximum) and (b) a $2,750 lecture fee. Hutchinson views the $2,750 lecture fee as providing him no upside potential (that is, no sharing in the potential additional operating income that arises if the seminar is highly attended). He suggests instead that he receive 50% of the operating income to UKBS (if positive) from the one-day seminar and no other payments. The dean of UKBS quickly agrees to Hutchinson's proposal after confirming that Hutchinson is willing to pay his own airfare and accommodation and deliver the seminar irrespective of the number of executives signed up to attend.

Required

1. What is UKBS's breakeven point (in number of executives attending) if
   a. Hutchinson accepts the regular compensation package of $3,800 expenses and a $2,750 lecture fee?

b. Hutchinson receives 50% of the operating income to UKBS (if positive) from the one-day seminar and no other payments?

Comment on the results for (a) and (b).

2. Hutchinson gave the one-day seminar at UKBS in 2012 (60 attended), 2013 (75 attended), and 2014 (120 attended). How much was Hutchinson paid by UKBS for the one-day seminar under the 50% of UKBS's operating income compensation plan in (a) 2012, (b) 2013, and (c) 2014? (Assume that the $350 charge per executive attending and UKBS's fixed and variable costs are the same each year.)

3. After the 2014 seminar, the dean at UKBS suggested to Hutchinson that the 50%–50% profit-sharing plan was resulting in Hutchinson getting excessive compensation and that a more equitable arrangement to UKBS be used in 2015. How should Hutchinson respond to this suggestion?

3-34 CVP computations with sensitivity analysis—Advanced. Hoot Washington is the newly elected charismatic leader of the Western Party. He is the darling of the right-wing media. His "take no prisoners" attitude has left many an opponent on a talk show feeling run over by a Mack truck.

◄ **LO 3**
1. Breakeven number in units, 252,708 copies (rounded)

Media Publishers is negotiating to publish Washington's *Manifesto*, a new book that promises to be an instant bestseller. The fixed costs of producing and marketing the book will be $600,000. The variable costs of producing and marketing will be $4.80 per book. These costs are before any payments to Washington. Washington negotiates an up-front payment of $3.60 million plus a 15% royalty rate on the net sales price of each book. The net sales price is the listed bookstore price of $36 minus the margin paid to the bookstore to sell the book. The normal book-store margin of 30% of the listed bookstore price is expected to apply.

Required

1. How many copies must Media Publishers sell to (a) break even and (b) earn a target operating profit of $2.4 million?
2. Examine the sensitivity of the breakeven point to the following changes:

   a. Decreasing the normal bookstore margin to 20% of the listed bookstore price of $36.
   b. Increasing the listed bookstore price to $48 while keeping the bookstore margin at 30%.

3-35 CVP analysis, service firm. Wildlife Escapes generates average revenue of $9,200 per person on its five-day package tours to wildlife parks in Kenya. The variable costs per person are

◄ **LO 3**
1. 450 package tours

Airfare	$3,500
Hotel accommodations	1,200
Meals	480
Ground transportation	920
Park tickets and other costs	240

Annual fixed costs total $1,287,000.

Required

1. Calculate the number of package tours that must be sold to break even.
2. Calculate the revenue needed to earn a target operating income of $214,500.
3. If fixed costs increase by $40,500, what decrease in variable costs must be achieved to maintain the breakeven point calculated in requirement 1?

3-36 CVP, target operating and net income. Carumba Inc.'s 2015 budget includes the following items:

◄ **LO 3**
1. BEP, $34.75

Sales	80,000 units
Production	80,000 units
Direct materials used	$600,000
Direct labour	400,000
Variable overhead	720,000
Fixed overhead	400,000
Variable selling costs	260,000
Fixed selling costs	250,000
Administrative costs (all fixed)	150,000

The company's tax rate is 40%.

Required

1. At what price would the company break even?
2. If the company were to sell only 60,000 units, what price would produce a before-tax profit of 20% of sales?
3. Majestix Inc. has offered to supply Carumba with 80,000 units at a price of $28/unit. Should Carumba accept the offer? Explain.
4. What price would produce an after-tax profit of $350,000?

3-37 **CVP, target income, service firm.** Teddy Bear Daycare provides daycare for children Mondays through Fridays. Its monthly variable costs per child are

Lunch and snacks	$ 100
Educational supplies	75
Other supplies (paper products, toiletries, etc.)	25
Total	$ 200

Monthly fixed costs consist of

Rent	$2,000
Utilities	300
Insurance	300
Salaries	2,500
Miscellaneous	500
	$5,600

Teddy Bear charges each parent $500 per child.

Required

1. Calculate the breakeven point.
2. Teddy Bear's target operating income is $10,400 per month. Compute the number of children that must be enrolled to achieve the target operating income.
3. Teddy Bear lost its lease and had to move to another building. Monthly rent for the new building is $3,000. At the suggestion of parents, Teddy Bear plans to take children on field trips. Monthly costs of the field trips are $1,000. By how much should Teddy Bear increase fees per child to meet the target operating income of $10,400 per month, assuming the same number of children as in requirement 2?

3-38 **CVP and income taxes.** R. A. Ro and Company, a manufacturer of quality handmade walnut bowls, has experienced a steady growth in sales for the past five years. However, increased competition has led Ro, the president, to believe that an aggressive marketing campaign will be necessary next year to maintain the company's present growth.

To prepare for next year's marketing campaign, the company's controller has prepared and presented Ro with the following data for the current year, 2016:

Variable costs (per bowl):	
Direct manufacturing labour	$ 9.60
Direct materials	3.90
Variable overhead (manufacturing, marketing, distribution, customer service, and administration)	3.00
Total variable costs	$ 16.50
Fixed costs:	
Manufacturing	$ 30,000
Marketing, distribution, and customer service	48,000
Administrative	84,000
Total fixed costs	$162,000
Selling price per bowl	$30.00
Expected revenues, 2016 (20,000 units)	$600,000
Income tax rate	40%

Required

1. What is the projected net income for 2016?
2. What is the breakeven point in units for 2016?
3. Ro has set the revenue target for 2017 at a level of $660,000 (or 22,000 bowls). He believes an additional marketing cost of $13,500 for advertising in 2017, with all other costs remaining constant, will be necessary to attain the revenue target. What will be the net income for 2017 if the additional $13,500 is spent and the revenue target is met?
4. What will be the breakeven point in revenues for 2017 if the additional $13,500 is spent for advertising?
5. If the additional $13,500 is spent for advertising in 2017, what is the required 2017 revenue for 2017's net income to equal 2016's net income?
6. At a sales level of 22,000 units, what maximum amount can be spent on advertising if a 2017 net income of $72,000 is desired?

3-39 CVP, income taxes, manufacturing decisions. Prairie Ltd. currently manufactures a single product in its Saskatoon factory. Last year's results (based on sales volume of 25,000 units) were

◄ **LO 4, 5**
1. BEP, 15,433 units

Sales		$1,350,000
Variable costs	$ 742,500	
Fixed costs	375,000	1,117,500
Operating income		232,500
Income taxes (40%)		93,000
Net income		$ 139,500

Required

1. Using last year's data, calculate Prairie's breakeven point in units and calculate the margin of safety in units.
2. How many units of product would Prairie have had to sell last year if it wished to earn $225,000 in net income?
3. In an attempt to improve its product quality, Prairie is considering replacing one of its current component parts. This part costs $7.50 (one component per finished unit), and Prairie is evaluating a new and better part that has a cost of $9.80 per unit. The company would simultaneously expand its production by investing in a machine that costs $25,000. This machine has no salvage value and would be depreciated on a straight-line basis over five years (assume this is acceptable for both financial-statement and tax purposes). If these changes are made and selling price is held constant:

   a. Calculate the new breakeven point in units.
   b. Determine how many units of product must be sold next year to achieve the same net income after taxes as last year.

4. Instead of the changes in requirement 3, the company is considering adding a higher-quality product to its sales mix. This new product would sell for $95 and variable costs per unit would increase by 60% over the old product. Total unit sales are forecast to increase to 50,000 units (which is in the company's current capacity—no additional fixed costs are needed) and the sales mix is estimated to be 3:2 (old product to new product). If Prairie introduces this new product at the planned sales mix, calculate the new breakeven point in sales dollars.

3-40 CVP, shoe stores. The Walk Rite Shoe Company operates a chain of shoe stores. The stores sell ten different styles of inexpensive men's shoes with identical unit costs and selling prices. A unit is defined as a pair of shoes. Each store has a store manager who is paid a fixed salary. Individual salespeople receive a fixed salary and a sales commission. Walk Rite is trying to determine the desirability of opening another store, which is expected to have the following revenue and cost relationships:

◄ **LO 3**
1. a. BEP, 40,000 units

Selling price	$30.00
Unit variable cost per pair:	
Cost of shoes	19.50
Sales commissions	1.50
Total variable costs	$21.00

Annual fixed costs:	
Rent	$ 60,000
Salaries	200,000
Advertising	80,000
Other fixed costs	20,000
Total fixed costs	$360,000

Required

(Consider each question independently.)

1. What is the annual breakeven point in (a) units sold and (b) revenues?
2. If 35,000 units are sold, what will be the store's operating income (loss)?
3. If sales commissions were discontinued for individual salespeople in favour of an $81,000 increase in fixed salaries, what would be the annual breakeven point in (a) units sold and (b) revenues?
4. Refer to the original data. If the store manager were paid $0.30 per unit sold in addition to his current fixed salary, what would be the annual breakeven point in (a) units sold and (b) revenues?
5. Refer to the original data. If the store manager were paid $0.30 per unit commission on each unit sold in excess of the breakeven point, what would be the store's operating income if 50,000 units were sold? (This $0.30 is in addition to both the commission paid to the sales staff and the store manager's fixed salary.)

3-41 CVP, shoe stores (continuation of 3-40). Refer to requirement 3 of 3-40. In this problem assume the role of the owner of Walk Rite.

Required

1. Calculate the number of units sold where the operating income under (a) a fixed-salary plan and (b) a lower fixed-salary-and-commission plan (for salespeople only) would be equal. Above that number of units sold, one plan would be more profitable than the other; below that number of units sold, the reverse would occur.
2. As owner, which sales compensation plan would you choose if forecasted annual sales of the new store were at least 55,000 units? What do you think of the motivation aspects of your chosen compensation plan?
3. Suppose the target operating income is $168,000. How many units must be sold to reach the target under (a) the fixed-salary plan and (b) the lower fixed-salary-and-commission plan?
4. You open the new store on January 1, 2016, with the original salary-plus-commission compensation plan in place. Because you expect the cost of the shoes to rise due to inflation, you place a firm bulk order for 50,000 shoes and lock in the $19.50 per unit price. But, toward the end of the year, only 48,000 pairs of shoes are sold, and you authorize a markdown of the remaining inventory to $18 per unit. Finally all units are sold. Salespeople, as usual, get paid a commission of 5% of revenues. What is the annual operating income for the store?

3-42 Uncertainty and expected costs. Dawmart Corp., an international retail giant, is considering implementing a new business-to-business (B2B) information system for processing purchase orders. The current system costs Dawmart $1,000,000 per month and $40 per order. Dawmart has two options: a partially automated B2B and a fully automated B2B system. The partially automated B2B system will have a fixed cost of $5,000,000 per month and a variable cost of $30 per order. The fully automated B2B system will have fixed costs of $10,000,000 per month and variable costs of $20 per order.

Based on data from the last two years, Dawmart has determined the following distribution on monthly orders:

Monthly Number of Orders	Probability
300,000	0.10
400,000	0.25
500,000	0.40
600,000	0.15
700,000	0.10

Required

1. Prepare a table showing the cost of each plan for each quantity of monthly orders.
2. What is the expected cost of each plan?
3. In addition to the information systems costs, what other factors should Dawmart consider before deciding to implement a new B2B system?

3-43 CVP analysis, decision making. (M. Rajan, adapted) Tocchet Company manufactures CB1, a citizens' band radio that is sold mainly to truck drivers. The company's plant in Camden has an annual capacity of 75,000 units. Tocchet currently sells 60,000 units at a selling price of $148. It has the following cost structure:

Variable manufacturing costs per unit	$ 63
Fixed manufacturing costs	1,012,000
Variable marketing and distribution costs per unit	15
Fixed marketing and distribution costs	780,000

Required

(Consider each question separately.)
1. Calculate the breakeven volume in units and in dollars.
2. The marketing department indicates that decreasing the selling price to $140 would stimulate sales to 70,000 units. This strategy will require Tocchet to increase its fixed costs, although variable costs per unit will remain the same as before. What is the *maximum* increase in fixed costs for which Tocchet will find it worthwhile to reduce the selling price?
3. The manufacturing department proposes changes in the manufacturing process to add new features to the CB1 product. These changes will increase fixed manufacturing costs by $150,000 and variable manufacturing costs per unit by $3.20. At its current sales quantity of 60,000 units, what is the *minimum* selling price above which Tocchet will find it worthwhile to add these new features?

3-44 Revenue mix, two products. The Goldman Company retails two products, a standard and a deluxe version of a luggage carrier. The budgeted statement of comprehensive income is as follows:

	Standard Carrier	Deluxe Carrier	Total
Units sold	150,000	50,000	200,000
Revenues @ $20 and $30 per unit	$3,000,000	$1,500,000	$4,500,000
Variable costs @ $14 and $18 per unit	2,100,000	900,000	3,000,000
Contribution margins @ $6 and $12 per unit	$ 900,000	$ 600,000	1,500,000
Fixed costs			1,200,000
Operating income			$ 300,000

Required

1. Compute the breakeven point in units, assuming that the planned revenue mix is maintained.
2. Compute the breakeven point in units (a) if only standard carriers are sold and (b) if only deluxe carriers are sold.
3. Suppose 200,000 units are sold, but only 20,000 are deluxe. Compute the operating income. Compute the breakeven point if these relationships persist in the next period. Compare your answers with the original plans and the answer in requirement 1. What is the major lesson of this problem?

3-45 CVP, movie production. Panther Productions has just finished production of the most recent sequel in its Illinois Jones series. The film cost $22 million to produce. Most production personnel and actors were paid a fixed salary (included in the $22 million); however, the two major stars of the film, Chevy Harrison and Sean Connelly, as well as the director and producer, Stephen Lucas and George Spielberg, all received equity interests in the film. In addition, the distributor of the film, Parimont Productions, receives royalties in exchange for its investment of $6.5 million to promote the film. The actors each receive 4% of revenues, the director and producer each receive 8% of revenues, and Parimont receives 12% of the revenues. Panther receives 65% of the total box office receipts, and out of this amount it pays the royalties to the actors, director, producer, and promoter.

Required

1. What is the breakeven point on the film to Panther Productions expressed in terms of (a) revenues received by Panther and (b) total box office receipts?
2. Assume that, in its first year of release, the box office receipts for the movie total $320 million. What is the operating income to Panther from the movie in its first year?

3-46 CVP, cost structure differences, movie production (continuation of 3-45). Panther Productions is negotiating the next sequel to its Illinois Jones series. This negotiation is proving more difficult than for the original movie. There is a risk that the series may have peaked and the total box office receipts will drop. The budgeted production cost (excluding royalty payments) is $32 million. The agent negotiating for Harrison and Connelly proposes either of two contracts:

- ■ Contract A. Fixed salary component of $50 million for both (combined) with no residual interest in the revenues.

- ■ Contract B. Fixed salary component of $8 million for both (combined) plus a residual of 3% each of the revenues.

The promoter, Parimont Productions, will invest a minimum of $12 million of its own money, and because of its major role in the success of the last film, it will now be paid 18% of the revenues received from the total box office receipts. Panther continues to receive 65% of the total box office receipts (out of which comes the royalty payments).

Required

1. What is the breakeven point for Panther Productions expressed in terms of (a) revenues received by that company and (b) total box office receipts—for contracts A and B? Explain the difference between the breakeven points for contracts A and B.
2. Assume the sequel achieves $280 million in box office revenues. What is the operating income to Panther under each of the contracts? Comment on the results.

3-47 Multi-product breakeven, decision making. Bonavista Cribs manufactures baby cribs. It currently produces one model, the Surrey crib, and it is priced at $600. Variable manufacturing costs are $210 per unit and variable shipping costs are $60 per unit. Fixed costs are $2,574,000. In 2014, it sold 9,800 units of the Surrey crib. One of Bonavista's customers, Dover Corporation, has asked if Bonavista could manufacture a new style of crib, the Shilo, for 2015. Dover will pay $350 for the Shilo. The variable costs to produce the new crib are estimated to be $180 per unit and Dover will pay for the shipping. Bonavista has sufficient manufacturing capacity and will not incur any additional fixed costs. Bonavista estimates that in 2015, it will sell 10,000 units of Surrey and 4,000 units of Shilo.

The president of Bonavista checked the impact of accepting the Dover order on the breakeven sales revenues for 2015 and was surprised to find that the dollar sales revenues required to break even using the sales mix for 2015 appeared to increase. He was not sure that his numbers were correct, but if they were, he felt inclined to reject the Dover order. He has asked for your advice.

Required

1. Calculate the breakeven point in units and sales dollars for 2014.
2. Calculate the breakeven point in units and sales dollars for 2015 at the expected sales mix.
3. Explain why the breakeven points in sales dollars calculated in requirements 1 and 2 are different.
4. What would you advise the president to do? Support your recommendations.

3-48 Choosing between compensation plans, operating leverage. (CMA, adapted) Marston Corporation manufactures pharmaceutical products that are sold through a network of sales agents. The agents are paid a commission of 18% of sales. The statement of comprehensive income for the year ending December 31, 2014, under two scenarios, is as follows:

Marston Corporation
Statement of Comprehensive Income
for the Year Ending December 31, 2014

	Using Sales Agents		Using Own Sales Force	
Sales		$26,000,000		$26,000,000
Cost of goods sold				
Variable	$11,700,000		$11,700,000	
Fixed	2,870,000	14,570,000	2,870,000	14,570,000
Gross margin		11,430,000		11,430,000
Marketing costs				
Commissions	4,680,000		2,600,000	
Fixed costs	3,420,000	8,100,000	5,500,000	8,100,000
Operating income		$3,330,000		$ 3,330,000

Marston is considering hiring its own sales staff to replace the network of agents. Marston will pay its salespeople a commission of 10% and incur additional fixed costs of $2,080,000.

Required

1. Calculate Marston Corporation's 2014 contribution margin percentage, breakeven revenues, and degree of operating leverage under each of the two scenarios. (You will first have to recast the 2014 statement of comprehensive income assuming Marston had hired its own sales staff.)
2. Describe the advantages and disadvantages of each type of sales alternative.
3. In 2015, Marston uses its own salespeople who demand a 15% commission. If all other cost behaviour patterns are unchanged, how much revenue must the salespeople generate in order to earn the same operating income as in 2014?

3-49 **Special-order decision.** Manitoba Production Corporation (MPC) specializes in the manufacture of one-litre plastic bottles. The plastic moulding machines are capable of producing 100 bottles per hour. The firm estimates that the variable cost of producing a plastic bottle is 25 cents. The bottles are sold for 55 cents each.

◀ **LO 4**
1. Additional income, $46,000

Management has been approached by a local toy company that would like the firm to produce a moulded plastic toy for it. The toy company is willing to pay $3.40 per unit for the toy. The unit variable cost to manufacture the toy will be $2.70. In addition, MPC would have to incur a cost of $24,000 to construct the mould required exclusively for this order. Because the toy uses more plastic and is of a more intricate shape than a bottle, a moulding machine can produce only 40 units per hour. The customer wants 100,000 units. Assume that MPC has a total capacity of 10,000 machine hours available during the period in which the toy company wants delivery of the toys. The firm's fixed costs, *excluding* the costs to construct the toy mould, during the same period will be $220,000.

Required

1. Suppose the demand for its bottles is 750,000 units, and the special toy order has to be either taken in full or rejected totally. Should MPC accept the special toy order? Explain your answer.
2. Suppose the demand for its bottles is 850,000 units, and the special toy order has to be either taken in full or rejected totally. Should MPC accept the special toy order? Explain your answer.
3. Suppose the demand for its bottles is 900,000 units, and the special toy order has to be either taken in full or rejected totally. Should MPC accept the special toy order? Explain your answer.

3-50 **CVP, sensitivity analysis.** Technology of the Past (TOP) produces old-fashioned simple corkscrews. Last year was not a good year for sales but TOP expects the market to pick up this year. Last year's statement of comprehensive income showed

◀ **LO 4**
1. OI, $5,000

Sales revenues ($4 per corkscrew)	$40,000
Variable cost ($3 per corkscrew)	30,000
Contribution margin	10,000
Fixed cost	6,000
Operating income	$ 4,000

To take advantage of the anticipated growth in the market, TOP is considering various courses of action:

1. Do nothing. If TOP does nothing, it expects sales to increase by 10%.
2. Spend $2,000 on a new advertising campaign that is expected to increase sales by 50%.
3. Raise the price of the corkscrew to $5. This is expected to decrease sales quantities by 20%.
4. Redesign the classic corkscrew and increase the selling price to $6 while increasing the variable costs by $1 per unit. The sales level is not expected to change from last year.

Required

Evaluate each of the alternatives considered by TOP. What should TOP do?

3-51 **Non-profit institution.** The City of Vancouver makes an $850,000 lump-sum budget appropriation to run a safe injection site for a year. All the appropriation is to be spent. The variable costs average $16 per patient visit. Fixed costs are $500,000 per year.

◀ **LO 4**
1. 21,875 patient visits

Required

1. Compute the number of patient visits that the budget allocation will cover.
2. Suppose the total budget for the following year is reduced by 10%. Fixed costs are to remain the same. The same level of service on each patient visit will be maintained. Compute the number of visits that could be provided in a year.

3. As in requirement 2, assume a budget reduction of 10%. Fixed costs are to remain the same. By how much would variable costs have to decline in order to provide the same number of visits?

3-52 CVP, non-profit event planning. The Windsor Chamber of Commerce is planning its annual event. There are two possible plans:

a. Hold the event at a local hotel. The fixed rental cost would be $2,700 and the charge for meals would be $110 per person.

b. Hold the event at the University of Windsor. The fixed rental fee for the facility would be much higher at $7,000, and the Chamber would also spend another $500 in permits. However, the Chamber could use the local caterer and the per-unit charge for meals would drop to $75 per person.

The Chamber of Commerce budgets $5,000 for administration and marketing. Entertainment will cost $4,000 regardless of the venue chosen. Tickets to the event will be $175 per person. All other costs, such as door prizes and drinks, will be paid for by corporate sponsors.

Required

1. Compute the breakeven point for each plan in terms of tickets sold.
2. For each plan, compute the operating income of the event (a) if 100 people attend, (b) if 250 people attend. Comment on your results.
**3.** At what level of tickets sold will the two plans have the same operating income?

3-53 CVP under uncertainty. In your new position as supervisor of product introduction, you have to decide on a pricing strategy for a talking doll specialty product with the following cost structure:

Variable costs per unit	$ 60
Fixed costs	240,000

The dolls are manufactured upon receipt of orders, so the inventory levels are insignificant. Your market research assistant is very enthusiastic about probability models and has presented the results of his price analysis in the following form:

a. If you set the selling price at $120 per unit, the probability distribution of revenues is uniform between $360,000 and $720,000. Under this distribution, there is a 0.50 probability of equalling or exceeding revenues of $540,000.

b. If you lower the selling price to $84 per unit, the distribution remains uniform, but it shifts up to the $720,000 − $1,080,000 range. Under this distribution, there is a 0.50 probability of equalling or exceeding revenues of $900,000.
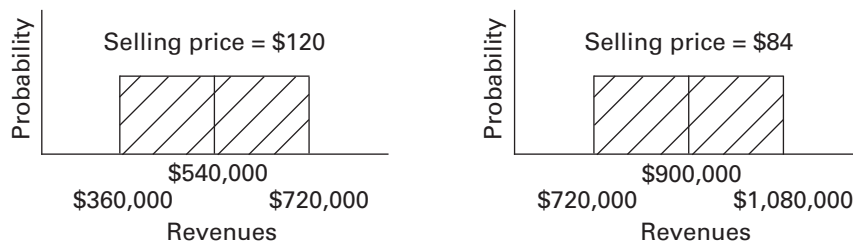
Required

1. This is your first big contract and, above all, you want to show an operating income. You decide to select the strategy that maximizes the probability of breaking even or earning a positive operating income.

   a. What is the probability of at least breaking even with a selling price of $120 per unit?
   b. What is the probability of at least breaking even with a selling price of $84 per unit?

2. Your assistant suggests that maximum expected operating income might be a better objective to pursue. Which pricing strategy would result in the higher expected operating income? (Use the expected revenues under each pricing strategy when making expected operating-income computations.)

3-54 Governance, CVP analysis. Athabaska Ltd. produces a lens used for webcams. Summary data from its year 2014 statement of comprehensive income are as follows:

Revenues	$8,000,000
Variable costs	4,320,000
Fixed costs	3,900,000
Operating income	$(220,000)

The president of Athabaska, Roberta Klein, is very concerned about the company's operations. She has discussed the situation with the operations manager, Roland Bell, and the controller, Clara Walton.

After two weeks, Bell returns with a proposal. After researching various component parts, he advises that he can reduce variable costs to 48% of revenues by changing both the direct materials and the production process. The downside of this proposal is that the new direct material (although cheaper) results in more waste and is more toxic to the environment. Currently, waste produced in the production process does not require any special treatment and is disposed of normally. Bell points out that there are no current specific laws governing the disposal of this waste created by the use of the new material, and therefore production costs can be cut by using this material. Walton is concerned that this would expose the company to potential environmental liabilities. She believes that these potential future costs need to be estimated and included in the analysis. Bell disagrees and reiterates that there are no laws being violated and replies, "There is some possibility that we may have to incur costs in the future, but if we bring it up now, this proposal will not go through because our senior management always assumes these costs to be larger than they are. The market is very tough and we are in danger of shutting down the company. We don't want all our colleagues to lose their jobs. The only reason our competitors are making money is because they are doing exactly what I am proposing."

Required

1. Calculate Athabaska's breakeven revenues for the year 2014.
2. Calculate Athabaska's breakeven revenues if variable costs are 48% of revenues.
3. Calculate Athabaska's operating income in 2014 if variable costs had been 48% of sales.
4. What should Klein do?

3-55 Governance, CVP, cost analysis. Ahmed Diba is the controller of the Body Products Division of World Wide Drugs (WWD). It is located in Winnipeg, which is also the headquarters of WWD. Diba is helping develop a proposal for a new product to be called Vital Hair. This product is a cream to be rubbed on the scalp to restore hair growth. Cheryl Kelly, president of the division, and Diba are scheduled to make a presentation to the WWD executive committee on the expected profitability of Vital Hair. The fixed costs associated with the development, production, and marketing of Vital Hair are $25,000,000. Each customer will pay a doctor $98 per monthly treatment, of which $68 is paid to WWD. Diba estimates WWD's variable costs per treatment to be $28.50. Included in this $28.50 is $9.25 for potential product litigation costs. Kelly is livid at Diba for including the $9.25 estimate. She argues that it is imperative to get the R&D funds approved (and quickly) and that any number that increases the breakeven point reduces the likelihood of the Vital Hair project being approved. She notes that WWD has had few successful lawsuits against it, in contrast to some recent "horrendous" experiences of competitors with breast implant products. Moreover, she is furious that Diba put the $9.25 amount in writing. "How do we know there will be any litigation problem?" She suggests Diba redo the report excluding the $9.25 litigation risk cost estimate. "Put it on the chalkboard in the executive committee room, if you insist, but don't put it in the report sent to the committee before the meeting. You can personally raise the issue at the executive committee meeting and have a full and frank discussion."

Diba takes Kelly's "advice." He reports a variable cost of $19.25 per treatment in the proposal. Although he feels uneasy about this, he is comforted by the fact that he will flag the $9.25 amount to the executive committee in his forthcoming oral presentation.

One month later, Kelly walks into Diba's office. She is in a buoyant mood and announces she has just come back from an executive committee meeting that approved the Vital Hair proposal. Diba asks why he was not invited to the meeting. Kelly says the meeting was held in Toronto, and she decided to save the division money by going alone. She then says to Diba, "It is now time to get behind the new venture and help make it the success the committee and the team members believe it will be."

Required

1. What is the breakeven point (in units of monthly treatments) when WWD's variable costs (a) include the $9.25 estimate and (b) exclude the $9.25 estimate for potential product litigation costs?
2. Should Diba have excluded the $9.25 estimate in his report to the executive committee of WWD? Explain your answer.
3. What should Diba do in response to Kelly's decision to make the Vital Hair presentation on her own?

3-56 Deciding where to produce. (CMA, adapted) Domestic Engines Company produces the same power generators in two plants, a newly renovated, automated plant in Peona, and an older, less automated plant in Modine. The following data are available for the two plants:

	Peona	Modine
Selling price	$ 150.00	$ 150.00
Variable manufacturing cost per unit	$72.00	$88.00
Fixed manufacturing cost per unit	30.00	15.00
Variable marketing and distribution cost per unit	14.00	14.00
Fixed marketing and distribution cost per unit	19.00	14.50
Total cost per unit	135.00	131.50
Operating income per unit	$ 15.00	$ 18.50
Production rate per day	400 units	320 units
Normal annual capacity usage	240 days	240 days
Maximum annual capacity	300 days	300 days

All unit fixed costs are calculated based on a normal year of 240 working days. When the number of working days exceeds 240, variable manufacturing costs increase by $3.00 per unit in Peona and $8.00 per unit in Modine.

Domestic Engines is expected to produce and sell 192,000 generators during the coming year. Wanting to maximize the higher unit profit at Modine, Domestic Engines' production manager has decided to manufacture 96,000 units at each plant. This production plan results in Modine operating at capacity (320 units per day 300 days) and Peona operating at its normal volume (400 units per day 240 days).

Required

1. Determine the breakeven point for the Peona and Modine plants in units.
2. Calculate the operating income that would result from the division production manager's plan to produce 96,000 units at each plant.
3. Determine how the production of the 192,000 units should be allocated between Peona and Modine to maximize operating income for Domestic Engines. Show your calculations.

Collaborative Learning Cases

3-57 CVP analysis and revenue mix. Ronowski Company has three product lines of belts, A, B, and C, with contribution margins of $3.60, $2.40, and $1.20 respectively. The president forecasts sales of 200,000 units in the coming period, consisting of 20,000 units of A, 100,000 units of B, and 80,000 units of C. The company's fixed costs for the period are $306,000.

Required

1. What is the company breakeven point in units, assuming that the given revenue mix is maintained?
2. If the mix is maintained, what is the total contribution margin when 200,000 units are sold? What is the operating income?
3. What would operating income become if 20,000 units of A, 80,000 units of B, and 100,000 units of C were sold? What is the new breakeven point in units if these relationships persist in the next period?