After studying Chapter 4, you should be able to:

1. Determine the break-even point in number of units and in total sales dollars.
2. Determine the number of units that must be sold, and the amount of revenue required, to earn a targeted profit.
3. Prepare a profit-volume graph and a cost-volume-profit graph, and explain the meaning of each.
5. Explain the impact of risk, uncertainty, and changing variables on cost-volume-profit analysis.
Boyne USA Resorts owns and operates ski resorts in British Columbia, Washington, Montana, and Michigan, including two of the premier properties east of the Rocky Mountains, Boyne Highlands and Boyne Mountain. These two resort properties are located in Michigan’s northern Lower Peninsula near the picturesque village of Petoskey. Boyne earns a significant portion of its revenue from winter skiing. However, winter ski volume is heavily dependent on natural snowfall, which varies significantly from year to year. The business risk associated with such large snowfall variation is likely to continue into the foreseeable future as dramatic climactic changes, such as global warming, continue to occur. As a result, Boyne uses creative thinking along with various cost-volume-profit (CVP) analyses to develop activities that generate additional profit. Consider ski lifts at Boyne Highlands. These are important sources of revenue for the company. What other revenue-generating activities can you think of that Boyne might develop that revolve around such ski lifts? What additional variable and fixed costs might be involved with your activities, and what are the profit implications?

Boyne develops a variety of lift ticket packages to accommodate as many snow skiers and snow boarders as possible. For example, lift tickets are interchangeable between multiple Boyne properties and can be used during night skiing in certain areas. Like many ski resorts, Boyne markets spring, summer, and fall activities as well. For instance, many resorts promote mountain biking and hiking where participants purchase lift tickets for enclosed lifts, called gondolas, that carry them and their gear to the top of the mountain to begin their descent. Other ski resorts, such as Aspen, build elaborate children’s playgrounds and bungee trampolines at the top of the lifts to generate additional summer business in ski areas that might otherwise be dormant during the off season. Still other resorts build elaborate mountaintop restaurants and entertainment areas that can be reached only via ski lifts or gondolas, thereby increasing revenues and profits. Using CVP equations and contribution margin formulas, as well as cost-volume-profit and profit-volume graphs, Boyne spends considerable effort analyzing the revenue, cost, volume, and profit implications of these varied activities. With careful CVP analysis and sound judgment, Boyne attempts to make the best decisions possible to continue its profitability and reputation for fun.
Break-Even Point in Units and in Sales Dollars

Cost-volume-profit (CVP) analysis estimates how changes in costs (both variable and fixed), sales volume, and price affect a company’s profit. CVP is a powerful tool for planning and decision making. In fact, CVP is one of the most versatile and widely applicable tools used by managerial accountants to help managers make better decisions.

You might have read of companies using CVP analyses to reach important benchmarks, such as the break-even point. The break-even point is the point where total revenue equals total cost (i.e., the point of zero profit). New start-up companies typically experience losses (negative operating income) initially and view their first break-even period as a significant milestone. For example, online retail pioneer Amazon.com was founded in 1994 but did not break even for the first time until the fourth quarter of 2001! Also, managers become very interested in CVP analysis during times of economic trouble. For example, to the dismay of many of its shareholders, Sirius Satellite Radio signed shock-jock Howard Stern to a five-year, $500 million employment contract for joining the young company. As a result of Stern’s monstrous contract cost, some analysts estimated that Sirius would need an additional 2.4 million subscribers (i.e., customers) to reach break even. Therefore, CVP analysis helps managers pinpoint problems and find solutions.

CVP analysis can address many other issues as well, such as the number of units that must be sold to break even, the impact of a given reduction in fixed costs on the break-even point, and the impact of an increase in price on profit. Additionally, CVP analysis allows managers to do sensitivity analysis by examining the impact of various price or cost levels on profit.

Since CVP analysis shows how revenues, expenses, and profits behave as volume changes, it is natural to begin by finding the firm’s break-even point in units sold.

Here’s The Real Kicker

Kicker separates cost into fixed and variable components by using judgment. Because the bulk of manufacturing is outsourced, the cost of a set of speakers starts with the purchase price from the manufacturer. This cost is strictly variable in nature. Additional variable costs include duty (ranging from 9 to 30 percent—electronics are at the high end) and freight, as all units are shipped to Stillwater, Oklahoma, for distribution to customers. In-house labor may be needed at Kicker’s Stillwater facilities, and that cost has both fixed (salaried workers) and variable (temporary workers) components. The entire salaried staff in Stillwater, research and development, depreciation on property, plant and equipment, utilities, and so on, are all fixed.

These fixed and variable costs are used in cost-volume-profit analysis (performed monthly) and in management decision making. For example, the monthly cost-volume-profit figures can be used to monitor the effect of changing volume on profit and spotlight increases in fixed and variable costs. If costs are going up, management finds out about the problem early and can make adjustments.

Using Operating Income in Cost-Volume-Profit Analysis

Remember from Chapter 2 that operating income is total revenue minus total expense. For the income statement, expenses were classified according to function, that is, the manufacturing (or service provision) function, the selling function, and the administrative function. For CVP analysis, however, it is much more useful to organize costs into fixed and variable components. The focus is on the firm as a whole. Therefore, the costs refer to all costs of the company—production, selling, and administration. So variable costs are all costs that increase as more units are sold, including direct materials, direct labor, variable overhead, and variable selling and
administrative costs. Similarly, fixed costs include fixed overhead and fixed selling and administrative expenses. The income statement format that is based on the separation of costs into fixed and variable components is called the **contribution margin income statement**. Exhibit 4-1 shows the format for the contribution margin income statement.

**The Contribution Margin Income Statement**

<table>
<thead>
<tr>
<th>Sales</th>
<th>$ XXX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less: Total variable expense</td>
<td>(XXX)</td>
</tr>
<tr>
<td>Total contribution margin</td>
<td>$ XXX</td>
</tr>
<tr>
<td>Less: Total fixed expense</td>
<td>(XXX)</td>
</tr>
<tr>
<td>Operating income</td>
<td>$ XXX</td>
</tr>
</tbody>
</table>

The contribution margin income statement in Exhibit 4-1 contains a new term, **contribution margin**. **Contribution margin** is the difference between sales and variable expense. It is the amount of sales revenue left over after all the variable expenses are covered that can be used to contribute to fixed expense and operating income. The contribution margin can be calculated in total (as it was in Exhibit 4-1) or per unit.

Let’s use Whittier Company, a manufacturer of mulching lawn mowers, for an example. Whittier’s controller has budgeted the following production costs for the coming year:

- **Direct materials per mower**: $180
- **Direct labor per mower**: $100
- **Variable factory overhead per mower**: $25
- **Total fixed factory overhead**: $15,000
- **Fixed selling and administrative expense**: $30,000
- **Sales commission per mower**: $20

Whittier also has $30,000 in fixed selling and administrative expense, as well as a $20 sales commission on each mower sold. In the coming year, Whittier Company plans to produce and sell 1,000 mowers at a price of $400 each.

The total variable cost per mower includes direct materials, direct labor, variable overhead per unit, and the sales commission. Thus, variable cost per unit is $325 ($180 + $100 + $25 + $20). The total fixed expense includes fixed factory overhead and fixed selling and administrative expense; the total fixed expense is $45,000 ($15,000 + $30,000). Notice that both the variable cost per mower and the total fixed expense include all types of cost—both product and selling cost across the value chain.

The contribution margin income statement for Whittier Company for the coming year is shown in **Cornerstone 4-1**.

Notice that the contribution margin income statement in Cornerstone 4-1 shows a total contribution margin of $75,000. The per-unit contribution margin is $75 ($400 – $325). That is, every mower sold contributes $75 toward fixed expense and operating income.

What does Whittier’s contribution margin income statement show? First, of course, we notice that Whittier will more than break even at sales of 1,000 mowers. In fact, it expects an operating income of $30,000. Clearly, Whittier would just break even if total contribution margin equaled the total fixed cost. Let’s see how to calculate the break-even point.

**Break-Even Point in Units**

If the contribution margin income statement is recast as an equation, it becomes more useful for solving CVP problems. The operating income equation is:

\[
\text{Operating income} = \text{Sales} - \text{Total variable expenses} - \text{Total fixed expenses}
\]
Notice that all we have done is remove the total contribution margin line from Exhibit 4-1, since it is identical to sales minus total variable expense. This equation is the basis of all our coming work on CVP. We can think of it as the basic CVP equation.

We can expand the operating income equation by expressing sales revenues and variable expenses in terms of unit dollar amounts and the number of units sold. Specifically, sales revenue is equal to the unit selling price times the number of units sold, and total variable costs are equal to the unit variable cost times the number of units sold. With these expressions, the operating income equation becomes:

### HOW TO Prepare a Contribution Margin Income Statement

**Information:**
Whittier Company plans to sell 1,000 mowers at $400 each in the coming year. Product costs include:

<table>
<thead>
<tr>
<th>Cost</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct materials per mower</td>
<td>$180</td>
</tr>
<tr>
<td>Direct labor per mower</td>
<td>$100</td>
</tr>
<tr>
<td>Variable overhead per mower</td>
<td>$25</td>
</tr>
<tr>
<td>Total fixed factory overhead</td>
<td>$15,000</td>
</tr>
</tbody>
</table>

Variable selling expense is a commission of $20 per mower; fixed selling and administrative expense totals $30,000.

**Required:**
1. Calculate the total variable cost per unit.
2. Calculate the total fixed expense for the year.
3. Prepare a contribution margin income statement for Whittier Company for the coming year.

**Calculation:**

1. Variable cost per unit
   
   \[
   \text{Variable cost per unit} = \text{Direct materials} + \text{Direct labor} + \text{Variable factory overhead} + \text{Variable selling expense}
   \]
   
   \[
   = 180 + 100 + 25 + 20 = 325
   \]

2. Total fixed expense
   
   \[
   \text{Total fixed expense} = \text{Fixed factory overhead} + \text{Fixed selling and administrative expense}
   \]
   
   \[
   = 15,000 + 30,000 = 45,000
   \]

3. **Whittier Company**

   **Contribution Margin Income Statement**
   
   **For the Coming Year**

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Per Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales ($400 \times 1,000 mowers)</td>
<td>$400,000</td>
<td>$400</td>
</tr>
<tr>
<td>Total variable expense ($325 \times 1,000)</td>
<td>$325,000</td>
<td>$325</td>
</tr>
<tr>
<td>Total contribution margin</td>
<td>$ 75,000</td>
<td>$ 75</td>
</tr>
<tr>
<td>Total fixed expense</td>
<td>$ 45,000</td>
<td></td>
</tr>
<tr>
<td>Operating income</td>
<td>$30,000</td>
<td></td>
</tr>
</tbody>
</table>
Operating income = (Price × Number of units sold) − (Variable cost per unit × Number of units sold) − Total fixed cost

At the break-even point, of course, operating income equals $0. Let’s see how we can use the operating income equation to find the break-even point in units for Whittier Company. Recall that Whittier Company sells mowers at $400 each, and variable cost per mower is $325. Total fixed cost equals $45,000.

\[
\begin{align*}
($400 \times \text{Break-even units}) & - ($325 \times \text{Break-even units}) - $45,000 = 0 \\
($75 \times \text{Break-even units}) & - $45,000 = 0
\end{align*}
\]

Break-even units = \[
\frac{$45,000}{$75}
\]

Break-even units = 600

It is easy to see that a contribution margin income statement for Whittier Company, with sales of 600 mowers, does result in zero operating income.

<table>
<thead>
<tr>
<th>Sales ($400 × 600 mowers)</th>
<th>$240,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total variable expense ($325 × 600)</td>
<td>195,000</td>
</tr>
<tr>
<td>Total contribution margin</td>
<td>$45,000</td>
</tr>
<tr>
<td>Total fixed expense</td>
<td>45,000</td>
</tr>
<tr>
<td>Operating income</td>
<td>$0</td>
</tr>
</tbody>
</table>

When Whittier breaks even, total contribution margin equals total fixed cost. Exhibit 4-2 illustrates this important observation.

The operating income equation can be rearranged as follows to show the number of units at break even:

\[
\text{Break-even units} = \frac{\text{Total fixed cost}}{\text{Price} - \text{Variable cost per unit}}
\]

In other words, the break-even units are equal to the fixed cost divided by the contribution margin per unit. So, if a company sells enough units for the contribution margin to just cover fixed costs, it will earn zero operating income. In other words, it will break even. It is quicker to solve break-even problems using this break-even version of the operating income equation than it is using the original operating income equation. Cornerstone 4-2 shows how to use the break-even units equation to solve for the break-even point for Whittier Company.

**Contribution Margin and Fixed Cost at Break Even for Whittier Company**

![Diagram showing contribution margin and fixed costs at break even for Whittier Company](image)
**Break-Even Point in Sales Dollars**

In some cases when using CVP analysis, managers may prefer to use sales revenue as the measure of sales activity instead of units sold. A units sold measure can be converted to a sales revenue measure by multiplying the unit selling price by the units sold. For example, the break-even point for Whittier Company is 600 mulching mowers. Since the selling price for each lawn mower is $400, the break-even volume in sales revenue is $240,000 ($400 × 600).

Any answer expressed in units sold can be easily converted to one expressed in sales revenues, but the answer can be computed more directly by developing a separate formula for the sales revenue case. In this case, the important variable is sales dollars, so both the revenue and the variable costs must be expressed in dollars.
instead of units. Since sales revenue is always expressed in dollars, measuring that variable is no problem. Let’s look more closely at variable costs and see how they can be expressed in terms of sales dollars.

To calculate the break-even point in sales dollars, total variable costs are defined as a percentage of sales rather than as an amount per unit sold. For example, suppose that a company sells a product for $10 per unit and incurs a variable cost of $6 per unit. Of course, the remainder is contribution margin of $4 ($10 − $6). If 10 units are sold, total variable costs are $60 ($6 × 10 units). Alternatively, since each unit sold earns $10 of revenue and has $6 of variable cost, one could say that 60 percent of each dollar of revenue earned is attributable to variable cost ($6/$10). Thus, sales revenues of $100 would result in total variable costs of $60 (0.60 × $100).

This 60 percent is the variable cost ratio. The \textit{variable cost ratio} is the proportion of each sales dollar that must be used to cover variable costs. The variable cost ratio can be computed using either total data or unit data. The percentage of sales dollars remaining after variable costs are covered is the contribution margin ratio. The \textit{contribution margin ratio} is the proportion of each sales dollar available to cover fixed costs and provide for profit. In this example, if the variable cost ratio is 60 percent of sales, then the contribution margin ratio must be the remaining 40 percent of sales. It makes sense that the complement of the variable cost ratio is the contribution margin ratio. After all, total variable costs and total contribution margin sum to sales revenue.

Just as the variable cost ratio can be computed using total or unit figures, the contribution margin ratio, 40 percent in our example, can also be computed in these two ways. That is, one can divide the total contribution margin by total sales ($40/$100), or one can use the unit contribution margin divided by price ($4/$10). Naturally, if the variable cost ratio is known, it can be subtracted from 1 to yield the contribution margin ratio (1 − 0.60 = 0.40). \textit{Cornerstone 4-3} shows how the income statement can be expanded to yield the variable cost ratio and the contribution margin ratio.

\begin{align*}
\text{Operating income} &= \text{Sales} − \text{Total variable expenses} − \text{Total fixed expenses} \\
\text{Break-even sales} &= \frac{\text{Sales − Total variable expenses}}{\text{Contribution margin ratio}} \\
&= \frac{\$45,000}{1.00 − 0.8125} \\
&= \frac{\$45,000}{0.1875} \\
&= \$240,000
\end{align*}

So, Whittier Company has sales of $240,000 at the break-even point.

Notice in Cornerstone 4-3, Requirement 3, that sales revenue, variable costs, and contribution margin have been expressed as a percent of sales. The variable cost ratio is 0.8125 ($325,000/$400,000); the contribution margin ratio is 0.1875 (computed either as 1 − 0.8125, or $75,000/$400,000).

How do fixed costs relate to the variable cost ratio and contribution margin ratio? Since the total contribution margin is the revenue remaining after total variable costs are covered, it must be the revenue available to cover fixed costs and contribute to profit. How does the relationship of fixed cost to contribution margin affect operating income? There are three possibilities: Fixed cost can equal contribution margin; fixed cost can be less than contribution margin; or fixed cost can be greater than contribution margin. If fixed cost equals contribution margin, then operating income is $0 (the company is at break even). If fixed cost is less than contribution margin, the company earns a positive operating income. Finally, if fixed cost is greater than contribution margin, then the company faces an operating loss.

Now, let’s turn to the equation for calculating the break-even point in sales dollars. One way of calculating break-even sales revenue is to multiply the break-even units by the price. However, often the company is a multiple-product firm, and it can be difficult to figure the break-even point for each product sold. The operating income equation can be used to solve for break-even sales for Whittier as follows:

\begin{align*}
\text{Operating income} &= \text{Sales} − \text{Total variable expenses} − \text{Total fixed expenses} \\
\text{Break-even sales} &= \frac{\text{Sales − Total variable expenses}}{\text{Contribution margin ratio}} \\
&= \frac{\$45,000}{0.1875} \\
&= \$240,000
\end{align*}
**HOW TO Calculate the Variable Cost Ratio and the Contribution Margin Ratio**

**Information:**
Whittier Company plans to sell 1,000 mowers at $400 each in the coming year. Variable cost per unit is $325. Total fixed cost is $45,000.

**Required:**
1. Calculate the variable cost ratio.
2. Calculate the contribution margin ratio using unit figures.
3. Prepare a contribution margin income statement based on the budgeted figures for next year. In a column next to the income statement, show the percentages based on sales for sales, total variable costs, and total contribution margin.

**Calculation:**
1. Variable cost ratio = \[
\frac{\text{Variable cost per unit}}{\text{Price}} = \frac{325}{400} = 0.8125, \text{ or } 81.25%%
\]
2. Contribution margin per unit = Price – Variable cost per unit = $400 – $325 = $75
   Contribution margin ratio = \[
   \frac{\text{Contribution margin per unit}}{\text{Price}} = \frac{75}{400} = 0.1875, \text{ or } 18.75%%
   
3. Contribution margin income statement based on budgeted figures:

<table>
<thead>
<tr>
<th>Percent of Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales ($400 × 1,000 mowers)</td>
</tr>
<tr>
<td>Total variable expense (0.8125 × $400,000)</td>
</tr>
<tr>
<td>Total fixed expense</td>
</tr>
<tr>
<td>Operating income</td>
</tr>
</tbody>
</table>

$0 = \text{Break-even sales}
- (0.8125 × \text{Break-even sales}) – $45,000
$0 = \text{Break-even sales} (1.00 – 0.8125) – $45,000

Break-even sales = \[
\frac{45,000}{1.00 – 0.8125}
\]
Break-even sales = $240,000

So, Whittier Company has sales of $240,000 at the break-even point.

Just as it was quicker to use an equation to calculate the break-even units directly, it is helpful to have an equation to figure the break-even sales dollars. This equation is:

\[
\text{Break-even sales} = \frac{\text{Total fixed expenses}}{\text{Contribution margin ratio}}
\]

**Cornerstone 4-4** shows how to obtain the break-even point in sales dollars for Whittier Company.
Units and Sales Dollars Needed to Achieve a Target Income

While the break-even point is useful information and an important benchmark for relatively young companies, most companies would like to earn operating income greater than $0. CVP analysis gives us a way to determine how many units must be sold, or how much sales revenue must be earned, to earn a particular target income. Let’s look first at the number of units that must be sold to earn a targeted operating income.

Units to Be Sold to Achieve a Target Income

Remember that at the break-even point, operating income is $0. How can the equations used in our earlier break-even analyses be adjusted to find the number of units needed to achieve a target income?
that must be sold to earn a target income? The answer is that we add the target income amount to the fixed costs. Let’s try it two different ways—with the operating income equation and with the basic break-even equation.

Remember that the equation for the operating income is:

\[
\text{Operating income} = (\text{Price} \times \text{Units sold}) - (\text{Unit variable cost} \times \text{Units sold}) - \text{Fixed cost}
\]

To solve for positive operating income, replace the operating income term with the target income. Recall that Whittier Company sells mowers at $400 each, incurs variable cost per unit of $325, and has total fixed expense of $45,000. Suppose that Whittier wants to make a target operating income of $37,500. The number of units that must be sold to achieve that target income is calculated as follows:

\[
\$37,500 = ($400 \times \text{Number of units}) - ($325 \times \text{Number of units}) - 45,000
\]

\[
\text{Number of units} = \frac{($37,500 + 45,000)}{($400 - 325)} = 1,100
\]

Does the sale of 1,100 units really result in operating income of $37,500? The contribution margin income statement provides a good check.

<table>
<thead>
<tr>
<th>Sales ($400 \times 1,100)</th>
<th>$440,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total variable expense ($325 \times 1,100)</td>
<td>357,500</td>
</tr>
<tr>
<td>Total contribution margin</td>
<td>$ 82,500</td>
</tr>
<tr>
<td>Total fixed expense</td>
<td>45,000</td>
</tr>
<tr>
<td>Operating income</td>
<td>$ 37,500</td>
</tr>
</tbody>
</table>

Indeed, selling 1,100 units does yield operating income of $37,500.

The operating income equation can be used to find the number of units to sell to earn a targeted income. However, it is quicker to adjust the break-even units equation by adding target income to the fixed cost. This adjustment results in the following equation:

\[
\text{Number of units to earn target income} = \frac{\text{Fixed cost} + \text{Target income}}{\text{Price} - \text{Variable cost per unit}}
\]

This equation was used when calculating the 1,100 units needed to earn operating income of $37,500. Cornerstone 4-5 shows how Whittier Company can use this approach.

Another way to check the number of units to be sold to yield a target operating income is to use the break-even point. As shown in Cornerstone 4-5, Whittier must sell 1,100 lawn mowers, or 500 more than the break-even volume of 600 units, to earn a profit of $37,500. The contribution margin per lawn mower is $75. Multiplying $75 by the 500 lawn mowers above break even produces the operating income of $37,500 ($75 \times 500). This outcome demonstrates that contribution margin per unit for each unit above break even is equivalent to operating income per unit. Since the break-even point had already been computed, the number of lawn mowers to be sold to yield a $37,500 operating income could have been calculated by dividing the unit contribution margin into the target income and adding the resulting amount to the break-even volume.

In general, assuming that fixed costs remain the same, the impact on a firm’s income resulting from a change in the number of units sold can be assessed by multiplying the unit contribution margin by the change in units sold. For example, if 1,400 lawn mowers instead of 1,100 are sold, how much more operating income will be earned? The change in units sold is an increase of 300 lawn mowers, and the unit contribution margin is $75. Thus, operating income will increase by $22,500 ($75 \times 300) over the $37,500 initially calculated, and total operating income will be $60,000.
Sales Revenue to Achieve a Target Income

Consider the following question: How much sales revenue must Whittier generate to earn an operating income of $37,500? This question is similar to the one we asked earlier in terms of units but phrases the question directly in terms of sales revenue.

To answer the question, add the targeted operating income of $37,500 to the $45,000 of fixed cost and divide by the contribution margin ratio. Then, the equation is the following:

\[
\text{Sales dollars to earn target income} = \frac{\text{Fixed cost} + \text{Target income}}{\text{Contribution margin ratio}}
\]

Cornerstone 4-6 shows how to calculate the sales revenue needed to earn a target operating income of $37,500.

Whittier must earn revenues equal to $440,000 to achieve a profit target of $37,500. Since break-even sales equals $240,000, additional sales of $200,000 (\$440,000 - \$240,000) must be earned above break even. Notice that multiplying the contribution margin ratio by revenues above break even yields the profit of \$37,500 (0.1875 \times \$200,000). Above break even, the contribution margin ratio is a profit ratio; therefore, it represents the proportion of each sales dollar attributable to profit. For Whittier Company, every sales dollar earned above break even increases profits by \$0.1875.

In general, assuming that fixed costs remain unchanged, the contribution margin ratio can be used to find the profit impact of a change in sales revenue. To obtain the total

\[
\text{Sales dollars to earn target income} = \frac{\text{Fixed cost} + \text{Target income}}{\text{Contribution margin ratio}}
\]
HOW TO Solve for the Sales Needed to Earn a Target Operating Income

Information:
Whittier Company sells mulching mowers at $400 each. Variable cost per unit is $325, and total fixed costs are $45,000.

Required:
1. Calculate the contribution margin ratio.
2. Calculate the sales that Whittier Company must make to earn an operating income of $37,500.
3. Check your answer by preparing a contribution margin income statement based on the sales dollars calculated.

Calculation:
1. Contribution margin ratio = \( \frac{($400 - $325)}{400} \) = 0.1875
2. Sales dollars = \( \frac{(Target \ income + \ Total \ fixed \ expense)}{Contribution \ margin \ ratio} \) = \( \frac{($45,000 + $37,500)}{0.1875} \) = $440,000
3. Contribution margin income statement based on sales revenue of $440,000:

<table>
<thead>
<tr>
<th>Sales</th>
<th>$440,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total variable expense (0.8125 \times $440,000)</td>
<td>357,500</td>
</tr>
<tr>
<td>Total contribution margin</td>
<td>$ 82,500</td>
</tr>
<tr>
<td>Total fixed expense</td>
<td>45,000</td>
</tr>
<tr>
<td>Operating income</td>
<td>$ 37,500</td>
</tr>
</tbody>
</table>

Indeed, sales revenue of $440,000 does yield operating income of $37,500.

Graphs of Cost-Volume-Profit Relationships

It may be helpful in understanding CVP relationships to see them portrayed visually. A graphical representation can help managers see the difference between variable cost and revenue. It may also help them understand quickly what impact an increase or decrease in sales will have on the break-even point. Two basic graphs are the profit-volume graph and the cost-volume-profit graph.

The Profit-Volume Graph

A profit-volume graph visually portrays the relationship between profits (operating income) and units sold. The profit-volume graph is the graph of the operating income equation \([Operating \ income = (Price \times \ Units) - (Unit \ variable \ cost \times \ Units) - Total \ fixed \ cost]\). In this graph, operating income is the dependent variable, and units is the independent variable. Usually, values of the independent variable are
measured along the horizontal axis, and values of the dependent variable are measured along the vertical axis.

To make this discussion more concrete, a simple set of data will be used. Assume that Tyson Company produces a single product with the following cost and price data:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total fixed costs</td>
<td>$100</td>
</tr>
<tr>
<td>Variable costs per unit</td>
<td>5</td>
</tr>
<tr>
<td>Selling price per unit</td>
<td>10</td>
</tr>
</tbody>
</table>

Using these data, operating income can be expressed as:

\[
\text{Operating income} = (10 \times \text{Units}) - (5 \times \text{Units}) - 100 \\
= (5 \times \text{Units}) - 100
\]

This relationship can be graphed by plotting units along the horizontal axis and operating income (or loss) along the vertical axis. Two points are needed to graph a linear equation. While any two points will do, the two points often chosen are those that correspond to zero units sold and zero profits. When units sold are 0, Tyson experiences an operating loss of $100 (or an operating income of $100). The point corresponding to zero sales volume, therefore, is (0, $100). When no sales take place, the company suffers a loss equal to its total fixed costs. When operating income is $0, the units sold are equal to 20. The point corresponding to zero profits (break even) is (20, $0). These two points, plotted in Exhibit 4-3, define the profit graph.

The graph in Exhibit 4-3 can be used to assess Tyson’s profit (or loss) at any level of sales activity. For example, the profit associated with the sale of 40 units can

---

**Profit-Volume Graph**

![Exhibit 4-3](image-url)
be read from the graph by (1) drawing a vertical line from the horizontal axis to the profit line and (2) drawing a horizontal line from the profit line to the vertical axis. As illustrated in Exhibit 4-3, the profit associated with sales of 40 units is $100. The profit-volume graph, while easy to interpret, fails to reveal how costs change as sales volume changes. An alternative approach to graphing can provide this detail.

The Cost-Volume-Profit Graph

The cost-volume-profit graph depicts the relationships among cost, volume, and profits (operating income) by plotting the total revenue line and the total cost line on a graph. To obtain the more detailed relationships, it is necessary to graph two separate lines: the total revenue line and the total cost line. These two lines are represented by the following two equations:

\[
\text{Revenue} = \text{Price} \times \text{Units}
\]

\[
\text{Total cost} = (\text{Unit variable cost} \times \text{Units}) + \text{Fixed cost}
\]

Using the Tyson Company example, the revenue and cost equations are:

\[
\text{Revenue} = 10 \times \text{Units}
\]
\[
\text{Total cost} = (5 \times \text{Units}) + 100
\]

To portray both equations in the same graph, the vertical axis is measured in dollars, and the horizontal axis is measured in units sold.

Again, two points are needed to graph each equation. For the revenue equation, setting number of units equal to 0 results in revenue of $0; setting number of units equal to 20 results in revenue of $200. Therefore, the two points for the revenue equation are (0, $0) and (20, $200). For the cost equation, units sold of 0 and units sold of 20 produce the points (0, $100) and (20, $200). The graph of each equation appears in Exhibit 4-4.
Notice that the total revenue line begins at the origin and rises with a slope equal to the selling price per unit (a slope of 10). The total cost line intercepts the vertical axis at a point equal to total fixed costs and rises with a slope equal to the variable cost per unit (a slope of 5). When the total revenue line lies below the total cost line, a loss region is defined. Similarly, when the total revenue line lies above the total cost line, a profit region is defined. The point where the total revenue line and the total cost line intersect is the break-even point. To break even, Tyson Company must sell 20 units and, thus, receive $200 in total revenues.

Now, let's compare the information available from the CVP graph with that available from the profit-volume graph. To do so, consider the sale of 40 units. Recall that the profit-volume graph revealed that 40 units produced profits of $100. Examine Exhibit 4-4 again. The CVP graph also shows profits of $100, but it reveals more as well. The CVP graph discloses that total revenues of $400 and total costs of $300 are associated with the sale of 40 units. Furthermore, the total costs can be broken down into fixed costs of $100 and variable costs of $200. The CVP graph provides revenue and cost information not provided by the profit-volume graph. Unlike the profit-volume graph, some computation is needed to determine the profit associated with a given sales volume. Nonetheless, because of the greater information content, managers are likely to find the CVP graph a more useful tool.

Assumptions of Cost-Volume-Profit Analysis

The profit-volume and cost-volume-profit graphs just shown rely on some important assumptions. Some of these assumptions are as follows:

- There are identifiable linear revenue and linear cost functions that remain constant over the relevant range.
- Selling prices and costs are known with certainty.
- Units produced are sold—there are no finished goods inventories.
- Sales mix is known with certainty for multiple-product break-even settings (explained later in this chapter).

Linear Cost and Revenue Functions

CVP assumes that cost and revenue functions are linear; that is, they are straight lines. But, as was discussed in Chapter 3 on cost behavior, these functions are often not linear. They may be curved or step functions. Fortunately, it is not necessary to consider all possible ranges of production and sales for a firm. Remember that CVP analysis is a short-run decision-making tool. (We know that it is short run in orientation because some costs are fixed.) It is only necessary for us to determine the current operating range, or relevant range, for which the linear cost and revenue relationships are valid. Once a relevant range has been identified, then the cost and price relationships are assumed to be known and constant.

Prices and Costs Known with Certainty

In actuality, firms seldom know prices, variable costs, and fixed costs with certainty. A change in one variable usually affects the value of others. Often, there is a probability distribution to consider. Furthermore, there are formal ways of explicitly building uncertainty into the CVP model. These issues are explored in the section on incorporating risk and uncertainty into CVP analysis.

Production Equal to Sales

CVP assumes that all units produced are actually sold. There is no change in inventory over the period. The idea that inventory has no impact on break-even analysis makes sense. Break-even analysis is a short-run decision-making technique, so we are looking to cover all costs of a particular period of time. Inventory embodies costs of a previous period and is not considered in CVP analyses.

Constant Sales Mix

In single-product analysis, the sales mix is obviously constant—the one product accounts for 100 percent of sales. Multiple-product break-even analysis requires a constant sales mix. However, it is virtually impossible
to predict with certainty the sales mix. Typically, this constraint is handled in practice through sensitivity analysis. By using the capabilities of spreadsheet analysis, the sensitivity of variables to a variety of sales mixes can be readily assessed.

**Multiple-Product Analysis**

Cost-volume-profit analysis is fairly simple in the single-product setting. However, most firms produce and sell a number of products or services. Even though CVP analysis becomes more complex with multiple products, the operation is reasonably straightforward. Let’s see how we can adapt the formulas used in a single-product setting to a multiple-product setting by expanding the Whittier Company example.

Whittier Company has decided to offer two models of lawn mowers: a mulching mower that sells for $400 and a riding mower that sells for $800. The marketing department is convinced that 1,200 mulching mowers and 800 riding mowers can be sold during the coming year. The controller has prepared the following projected income statement based on the sales forecast:

<table>
<thead>
<tr>
<th></th>
<th>Mulching Mower</th>
<th>Riding Mower</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>$480,000</td>
<td>$640,000</td>
<td>$1,120,000</td>
</tr>
<tr>
<td>Less: Variable expenses</td>
<td>390,000</td>
<td>480,000</td>
<td>870,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$ 90,000</td>
<td>$160,000</td>
<td>$ 250,000</td>
</tr>
<tr>
<td>Less: Direct fixed expenses</td>
<td>30,000</td>
<td>40,000</td>
<td>70,000</td>
</tr>
<tr>
<td>Product margin</td>
<td>$ 60,000</td>
<td>$120,000</td>
<td>$ 180,000</td>
</tr>
<tr>
<td>Less: Common fixed expenses</td>
<td></td>
<td></td>
<td>26,250</td>
</tr>
<tr>
<td>Operating income</td>
<td></td>
<td></td>
<td>$ 153,750</td>
</tr>
</tbody>
</table>

Note that the controller has separated direct fixed expenses from common fixed expenses. The direct fixed expenses are those fixed costs that can be traced to each segment and would be avoided if the segment did not exist. The common fixed expenses are the fixed costs that are not traceable to the segments and would remain even if one of the segments was eliminated.

**Break-Even Point in Units**

The owner of Whittier is somewhat apprehensive about adding a new product line and wants to know how many of each model must be sold to break even. If you were given the responsibility of answering this question, how would you respond? One possible response is to use the equation developed earlier in which fixed costs were divided by the contribution margin. This equation presents a problem, however; it was developed for single-product analysis. For two products, there are two prices and two variable costs per unit. The variable cost per unit is derived from the income statement. For the mulching mower, total variable costs are $390,000 based on sales of 1,200 units, yielding a per-unit variable cost of $325 ($390,000/1,200). For the riding mower, total variable costs are $480,000 based on sales of 800 units, yielding a per-unit variable cost of $600 ($480,000/800). For the mulching mower, total variable costs are $390,000 based on sales of 1,200 units, yielding a per-unit variable cost of $325 ($390,000/1,200). For the riding mower, total variable costs are $480,000 based on sales of 800 units, yielding a per-unit variable cost of $600 ($480,000/800). Then, the mulching mower has a contribution margin per unit of $75 ($400 – $325); the riding mower has a contribution margin per unit of $200 ($800 – $600).

One possible solution is to apply the analysis separately to each product line. It is possible to obtain individual break-even points when income is defined as product margin. Break even for the mulching mower is as follows:
Mulching mower break-even units = \( \frac{\text{Fixed cost}}{\text{Price} - \text{Unit variable cost}} \)
\[= \frac{\$30,000}{\$75} = 400 \text{ units} \]

Break even for the riding mower can be computed as well:
Riding mower break-even units = \( \frac{\text{Fixed cost}}{\text{Price} - \text{Unit variable cost}} \)
\[= \frac{\$40,000}{\$200} = 200 \text{ units} \]

Thus, 400 mulching mowers and 200 riding mowers must be sold to achieve a break-even product margin. But a break-even product margin covers only direct fixed costs; the common fixed costs remain to be covered. Selling these numbers of lawn mowers would result in a loss equal to the common fixed costs. This level of sales is not the break-even point for the firm as a whole; somehow the common fixed costs must be factored into the analysis.

Allocating the common fixed costs to each product line before computing a break-even point may resolve this difficulty. The problem with this approach is that allocation of the common fixed costs is arbitrary. Thus, no meaningful break-even volume is readily apparent.

Another possible solution is to convert the multiple-product problem into a single-product problem. If this can be done, then all of the single-product CVP methodology can be applied directly. The key to this conversion is to identify the expected sales mix, in units, of the products being marketed. **Sales mix** is the relative combination of products being sold by a firm.

### Determining the Sales Mix
The sales mix is measured in units sold. For example, if Whittier plans on selling 1,200 mulching mowers and 800 riding mowers, then the sales mix in units is 1,200:800. Usually, the sales mix is reduced to the smallest possible whole numbers. Thus, the relative mix, 1,200:800, can be reduced to 12:8, and further reduced to 3:2. That is, Whittier expects that for every three mulching mowers sold, two riding mowers will be sold.

An endless number of different sales mixes can be used to define the break-even volume in a multiple-product setting. For example, a sales mix of 2:1 will define a break-even point of 550 mulching mowers and 275 riding mowers. The total contribution margin produced by this mix is \( \$96,250 \) \( (\$75 \times 550) + (\$200 \times 275) \). Similarly, if 350 mulching mowers and 350 riding mowers are sold (corresponding to a 1:1 sales mix), then the total contribution margin is also \( \$96,250 \) \( (\$75 \times 350) + (\$200 \times 350) \). Since total fixed costs are \( \$96,250 \), both sales mixes define break-even points. Fortunately, every sales mix need not be considered. Can Whittier really expect a sales mix of 2:1 or 1:1? For every two mulching mowers sold, does Whittier expect to sell a riding mower? Or, for every mulching mower, can Whittier really sell one riding mower?

According to Whittier’s marketing study, a sales mix of 3:2 can be expected. This is the ratio that should be used; all others can be ignored. The sales mix that is expected to prevail should be used for CVP analysis.

### Sales Mix and Cost-Volume-Profit Analysis
Defining a particular sales mix allows the conversion of a multiple-product problem into a single-product CVP format. Since Whittier expects to sell three mulching mowers for every two riding mowers, it can define the single product it sells as a package containing three mulching mowers and two riding mowers. By defining the product as a package, the multiple-product problem is converted into a single-product one. To use the approach of break-even point in units, the package selling price and the variable cost per package
HOW TO Calculate the Break-Even Units for a Multiple-Product Firm

Information:
Recall that Whittier Company sells two products: mulching mowers priced at $400 and riding mowers priced at $800. The variable costs per unit are $325 per mulching mower and $600 per riding mower. Total fixed expense is $96,250. Whittier’s expected sales mix is three mulching mowers to two riding mowers.

Required:
1. Form a package of mulching and riding mowers based on the sales mix, and calculate the package contribution margin.
2. Calculate the break-even point in units for mulching mowers and for riding mowers.
3. Check your answers by preparing a contribution margin income statement.

Calculation:
1. Each package consists of three mulching mowers and two riding mowers:

<table>
<thead>
<tr>
<th>Product</th>
<th>Price</th>
<th>Unit Variable Cost</th>
<th>Unit Contribution Margin</th>
<th>Sales Mix</th>
<th>Package Contribution Margin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mulching</td>
<td>$400</td>
<td>$325</td>
<td>$75</td>
<td>3</td>
<td>$225</td>
</tr>
<tr>
<td>Riding</td>
<td>800</td>
<td>600</td>
<td>200</td>
<td>2</td>
<td>400</td>
</tr>
<tr>
<td>Package total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$625</td>
</tr>
</tbody>
</table>

The three mulching mowers in the package yield $225 (3 × $75) in contribution margin. The two riding mowers in the package yield $400 (2 × $200) in contribution margin. Thus, a package of five mowers (three mulching and two riding) has a total contribution margin of $625.

2. Break-even packages = \( \frac{\text{Fixed cost}}{\text{Package contribution margin}} = \frac{96,250}{625} = 154 \) packages

Mulching mower break-even units = 154 × 3 = 462
Riding mower break-even units = 154 × 2 = 308

3. Income statement—break-even solution:

<table>
<thead>
<tr>
<th>Mulching Mower</th>
<th>Riding Mower</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>$184,800</td>
<td>$246,400</td>
</tr>
<tr>
<td>Less: Variable expenses</td>
<td>150,150</td>
<td>184,800</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$34,650</td>
<td>$61,600</td>
</tr>
<tr>
<td>Less: Total fixed expenses</td>
<td>96,250</td>
<td>96,250</td>
</tr>
<tr>
<td>Operating income</td>
<td>$ 0</td>
<td>$ 0</td>
</tr>
</tbody>
</table>
The complexity of the approach of break-even point in units increases dramatically as the number of products increases. Imagine performing this analysis for a firm with several hundred products. This observation seems more overwhelming than it actually is. Computers can easily handle a problem with so much data. Furthermore, many firms simplify the problem by analyzing product groups rather than individual products. Another way to handle the increased complexity is to switch from the units sold to the sales revenue approach. This approach can accomplish a multiple-product CVP analysis using only the summary data found in an organization’s income statement. The computational requirements are much simpler.

**Break-Even Point in Sales Dollars**

To illustrate the break-even point in sales dollars, the same examples will be used. However, the only information needed is the projected income statement for Whittier Company as a whole.

<table>
<thead>
<tr>
<th>Sales $1,120,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less: Variable costs $870,000</td>
</tr>
<tr>
<td>Contribution margin $250,000</td>
</tr>
<tr>
<td>Less: Fixed costs $96,250</td>
</tr>
<tr>
<td>Operating income $153,750</td>
</tr>
</tbody>
</table>

Notice that this income statement corresponds to the total column of the more detailed income statement examined previously. The projected income statement rests on the assumption that 1,200 mulching mowers and 800 riding mowers will be sold (a 3:2 sales mix). The break-even point in sales revenue also rests on the expected sales mix. (As with the units sold approach, different sales mixes will produce different results.)

With the income statement, the usual CVP questions can be addressed. For example, how much sales revenue must be earned to break even? Cornerstone 4-8 shows how to calculate the break-even point in sales dollars for a multiple-product firm.

The break-even point in sales dollars implicitly uses the assumed sales mix but avoids the requirement of building a package contribution margin. No knowledge of individual product data is needed. The computational effort is similar to that used in the single-product setting. Moreover, the answer is still expressed in sales revenue. Unlike the break-even point in units, the answer to CVP questions using sales dollars is still expressed in a single summary measure. The sales revenue approach, however, does sacrifice information concerning individual product performance.

**Concept Q&A**

Suppose a men’s clothing store sells two brands of suits: designer suits with a contribution margin of $600 each and regular suits with a contribution margin of $500 each. At break even, the store must sell a total of 100 suits a month. Last month, the store sold 100 suits in total but incurred an operating loss. There was no change in fixed cost, variable cost, or price. What happened?

**Possible Answer:**

Probably, the sales mix shifted toward the relatively lower contribution margin suits. For example, if the sales mix shifted so that the store sold 90 regular and 10 designer suits, it is easy to see why the total contribution margin per suit was $60.$ If the designer is the relatively lower contribution margin suit, the sales mix shifted away from the higher contribution margin suits.

**Objective**

Explain the impact of risk, uncertainty, and changing variables on cost-volume-profit analysis.
$2.6 billion reduction in its annual variable and fixed costs, as well as various reductions in its $144 million unit jet price, would affect its annual profit.¹

For a given sales mix, CVP analysis can be used as if the firm were selling a single product. However, when the prices of individual products change, the sales mix can be affected because consumers may buy relatively more or less of the product. Keep in mind that a new sales mix will affect the units of each product that need to be sold in order to achieve a desired profit target. If the sales mix for the coming period is uncertain, it may be necessary to look at several different mixes. In this way, a manager gains insight into the possible outcomes facing the firm.

Suppose that Whittier Company recently conducted a market study of the mulching lawn mower that revealed three different alternatives:

1. **Alternative 1:** If advertising expenditures increase by $8,000, then sales will increase from 1,600 units to 1,725 units.
2. **Alternative 2:** A price decrease from $400 to $375 per lawn mower will increase sales from 1,600 units to 1,900 units.
3. **Alternative 3:** Decreasing price to $375 and increasing advertising expenditures by $8,000 will increase sales from 1,600 units to 2,600 units.

¹“Airbus to report its first annual loss,” USA Today (January 18, 2007): 3B.
Should Whittier maintain its current price and advertising policies, or should it select one of the three alternatives described by the marketing study? 

The first alternative, increasing advertising costs by $8,000 with a resulting sales increase of 125 units, is summarized in Exhibit 4-5. This alternative can be analyzed by using the contribution margin per unit of $75. Since units sold increase by 125, the increase in total contribution margin is $9,375 ($75 \times 125$ units). However, since fixed costs increase by $8,000, profits only increase by $1,375 ($9,375 – $8,000). Notice that we need to look only at the incremental increase in total contribution margin and fixed expenses to compute the increase in total operating income.

For the second alternative, the price is dropped to $375 (from $400), and the units sold increase to 1,900 (from 1,600). The effects of this alternative are summarized in Exhibit 4-6. Here, fixed expenses do not change, so only the change in total contribution margin is relevant. For the current price of $400, the contribution margin per unit is $75 ($400 – $325), and the total contribution margin is $120,000 ($75 \times 1,600). For the new price, the contribution margin drops to $50 per unit ($375 – $325). If 1,900 units are sold at the new price, then the new total contribution margin is $95,000 ($50 \times 1,900). Dropping the price results in a profit decline of $25,000 ($120,000 – $95,000).
The third alternative calls for a decrease in the unit selling price and an increase in advertising costs. Like the first alternative, the profit impact can be assessed by looking at the incremental effects on contribution margin and fixed expenses. The incremental profit change can be found by (1) computing the incremental change in total contribution margin, (2) computing the incremental change in fixed expenses, and (3) adding the two results. As shown in Exhibit 4-7, the current total contribution margin (for 1,600 units sold) is $120,000. Since the new unit contribution margin is $50, the new total contribution margin is $130,000 ($50 \times 2,600 units). Thus, the incremental increase in total contribution margin is $10,000 ($130,000 – $120,000). However, to achieve this incremental increase in contribution margin, an incremental increase of $8,000 in fixed costs is needed. The net effect is an incremental increase in operating income of $2,000.

Of the three alternatives identified by the marketing study, the third alternative promises the most benefit. It increases total operating income by $2,000. The first alternative increases operating income by only $1,375, and the second decreases operating income by $25,000.

These examples are all based on a units sold approach. However, we could just as easily have applied a sales revenue approach. The answers would be the same.

**Introducing Risk and Uncertainty**

An important assumption of CVP analysis is that prices and costs are known with certainty. This assumption is seldom accurate. Risk and uncertainty are a part of business decision making and must be dealt with somehow. Formally, risk differs from uncertainty in that under risk, the probability distributions of the variables are known; under uncertainty, they are not known. For purposes of CVP analysis, however, the terms will be used interchangeably.

How do managers deal with risk and uncertainty? There are a variety of methods. First, of course, is that management must realize the uncertain nature of future prices, costs, and quantities. Next, managers move from consideration of a break-even point to what might be called a “break-even band.” In other words, given the uncertain nature of the data, perhaps a firm might break even when 1,800 to 2,000 units are sold instead of at the point estimate of 1,900 units. Further, managers may engage in sensitivity or what-if analysis. In this instance, a computer spreadsheet is helpful, as managers set up the break-even (or targeted profit) relationships and then check to see the impact that varying costs and prices have on quantity sold. Two concepts useful to management are margin of safety and operating leverage. Both of these concepts may be considered measures of risk. Each requires knowledge of fixed and variable costs.
The Margin of Safety

The **margin of safety** is the units sold or the revenue earned above the break-even volume. For example, if the break-even volume for a company is 200 units and the company is currently selling 500 units, then the margin of safety is 300 units (500 – 200). The margin of safety can be expressed in sales revenue as well. If the break-even volume is $200,000 and current revenues are $350,000, then the margin of safety is $150,000 ($350,000 – $200,000). In addition, margin of safety sales revenue can be expressed as a percentage of total sales dollars, which some managers refer to as the margin of safety ratio. In this example, the margin of safety ratio would be 60 percent ($300,000/$500,000). Exhibit 4-8 shows the calculation of the margin of safety and the margin of safety ratio. Cornerstone 4-9 shows the expected margin of safety for Whittier Company.

The margin of safety can be viewed as a crude measure of risk. There are always events, unknown when plans are made, that can lower sales below the original expected level. In the event that sales take a downward turn, the risk of suffering losses is less if a firm’s expected margin of safety is large than if the margin of safety is small. Managers who face a low margin of safety may wish to consider actions to increase sales or decrease costs. These steps will increase the margin of safety and lower the risk of incurring losses.

Operating Leverage

In physics, a lever is a simple machine used to multiply force. Basically, the lever multiplies the effort applied to create more work. The larger the load moved by a given amount of effort, the greater is the mechanical advantage. In financial terms, operating leverage is concerned with the relative mix of fixed costs and variable costs in an organization. It is sometimes possible to trade off fixed costs for variable costs. As variable costs decrease, the unit contribution margin increases, making the contribution of each unit sold that much greater. In such a case, fluctuations in sales have an increased effect on profitability. Thus, firms that have realized lower variable costs by increasing the proportion of fixed costs will benefit with greater increases in profits as sales increase than will firms with a lower proportion of fixed costs. Fixed costs are being used as leverage to increase profits. Unfortunately, it is also true that firms with a higher operating leverage will experience greater reductions in profits as sales decrease. **Operating leverage** is the use of fixed costs to extract higher percentage changes in profits as sales activity changes.

### Concept Q&A

Two companies have identical sales revenue of $15 million. Is it true that both have the same operating income and the same margin of safety? Is it possible that one company has a higher margin of safety?

Possible Answer:

It is not necessarily true that the two companies make the same operating income, but it is possible that one company has a higher margin of safety.
The degree of operating leverage (DOL) can be measured for a given level of sales by taking the ratio of contribution margin to operating income, as follows:

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

If fixed costs are used to lower variable costs such that contribution margin increases and operating income decreases, then the degree of operating leverage increases—signaling an increase in risk. Cornerstone 4-10 shows how to compute the degree of operating leverage for Whittier Company.

The greater the degree of operating leverage, the more that changes in sales will affect operating income. Because of this phenomenon, the mix of costs that an organization chooses can have a considerable influence on its operating risk and profit level. A company’s mix of fixed costs relative to variable costs is referred to as its cost structure. Often, a company changes its cost structure by taking on more of one type of cost in exchange for reducing its amount of the other type of cost. For example, as U.S. companies try to compete more effectively with foreign competitors’ significantly lower hourly labor costs (i.e., a variable cost), many are altering their cost structures.
structures by taking on more plant machine automation (i.e., a fixed cost) in exchange for using less labor.

To illustrate the impact of these concepts on management decision making, consider a firm that is planning to add a new product line. In adding the line, the firm can choose to rely heavily on automation or on labor. If the firm chooses to emphasize automation rather than labor, fixed costs will be higher, and unit variable costs will be lower. Relevant data for a sales level of 10,000 units follow:

<table>
<thead>
<tr>
<th>Automated System</th>
<th>Manual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>$1,000,000</td>
</tr>
<tr>
<td>Less: Variable costs</td>
<td>500,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>500,000</td>
</tr>
<tr>
<td>Less: Fixed costs</td>
<td>375,000</td>
</tr>
<tr>
<td>Operating income</td>
<td>$125,000</td>
</tr>
<tr>
<td>Unit selling price</td>
<td>$100</td>
</tr>
<tr>
<td>Unit variable cost</td>
<td>50</td>
</tr>
<tr>
<td>Unit contribution margin</td>
<td>50</td>
</tr>
</tbody>
</table>

The degree of operating leverage for the automated system is 4.0 ($500,000/$125,000). The degree of operating leverage for the manual system is 2.0 ($200,000/$100,000). What happens to profit in each system if sales increase by 40 percent? We can generate the following income statements to see the following:

<table>
<thead>
<tr>
<th>Automated System</th>
<th>Manual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>$1,400,000</td>
</tr>
<tr>
<td>Less: Variable costs</td>
<td>700,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>700,000</td>
</tr>
<tr>
<td>Less: Fixed costs</td>
<td>375,000</td>
</tr>
<tr>
<td>Operating income</td>
<td>$325,000</td>
</tr>
<tr>
<td>Unit selling price</td>
<td>$100</td>
</tr>
<tr>
<td>Unit variable cost</td>
<td>50</td>
</tr>
<tr>
<td>Unit contribution margin</td>
<td>50</td>
</tr>
</tbody>
</table>

Profits for the automated system would increase by $200,000 ($325,000 – $125,000) for a 160 percent increase. In the manual system, profits increase by only $80,000 ($180,000 – $100,000) for an 80 percent increase. The automated system has a greater percentage increase because it has a higher degree of operating leverage.

The degree of operating leverage can be used directly to calculate the change in operating income that would result from a given percentage change in sales.

Percentage change in operating income = DOL × Percent change in sales

Since sales are predicted to increase by 40 percent, and the DOL for the automated system is 4.0, operating income increases by 160 percent. Since operating income based on the original sales level is $125,000, the operating income based on the increased sales level would be $325,000 [($125,000 + ($125,000 × 1.6))]. Similarly, for the manual system, increased sales of 40 percent and DOL of 2.0 imply increased operating income of 80 percent. Therefore, operating income based on the increased sales level would be $180,000 [($100,000 + ($100,000 × 0.8))]. Cornerstone 4-11 illustrates the impact of increased sales on operating income using the degree of operating leverage.

In choosing between the two systems, the effect of operating leverage is a valuable piece of information. Higher operating leverage multiplies the impact of increased sales on income. However, the effect is a two-edged sword. As sales decrease, the automated system will also show much higher percentage decreases. Moreover, the increased operating leverage is available under the automated system because of the presence of increased fixed costs. The break-even point for the automated system is 7,500 units ($375,000/$50), whereas the break-even point for the manual system is 5,000 units ($100,000/$20). Thus, the automated system has greater operating
risk. The increased risk, of course, provides a potentially higher profit level as long as units sold exceed 9,167. Why 9,167? Because that is the quantity for which the operating income for the automated system equals the operating income for the manual system. The quantity at which two systems produce the same operating income is referred to as the indifference point. This number of units is computed by setting the operating income equations of the two systems equal and solving for number of units:

\[
\begin{align*}
50 \cdot \text{Units} - 375,000 &= 20 \cdot \text{Units} - 100,000 \\
\text{Units} &= 9,167
\end{align*}
\]

In choosing between the automated and manual systems, the manager must consider the likelihood that sales will exceed 9,167 units. If after careful study there is a strong belief that sales will easily exceed this level, then the choice is obviously the automated system. On the other hand, if sales are unlikely to exceed 9,167 units, then the manual system is preferable. Exhibit 4-9 summarizes the relative differences between the manual and automated systems in terms of some of the CVP concepts.

**Sensitivity Analysis and Cost-Volume-Profit**

The widespread use of personal computers and spreadsheets has placed sensitivity analysis within reach of most managers. An important tool, **sensitivity analysis** is a “what-if”

<table>
<thead>
<tr>
<th>Differences between a Manual and an Automated System</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Price</strong></td>
</tr>
<tr>
<td>Same</td>
</tr>
<tr>
<td><strong>Variable cost</strong></td>
</tr>
<tr>
<td><strong>Fixed cost</strong></td>
</tr>
<tr>
<td><strong>Contribution margin</strong></td>
</tr>
<tr>
<td><strong>Break-even point</strong></td>
</tr>
<tr>
<td><strong>Margin of safety</strong></td>
</tr>
<tr>
<td><strong>Degree of operating leverage</strong></td>
</tr>
<tr>
<td><strong>Down-side risk</strong></td>
</tr>
<tr>
<td><strong>Up-side potential</strong></td>
</tr>
</tbody>
</table>
technique that examines the impact of changes in underlying assumptions on an answer. It is relatively simple to input data on prices, variable costs, fixed costs, and sales mix and to set up formulas to calculate break-even points and expected profits. Then, the data can be varied as desired to see how changes impact the expected profit.

In the example on operating leverage, a company analyzed the impact on profit of using an automated versus a manual system. The computations were essentially done by hand, and too much variation is cumbersome. Using the power of a computer, it would be an easy matter to change the sales price in $1 increments between $75 and $125, with related assumptions about quantity sold. At the same time, variable and fixed costs could be adjusted. For example, suppose that the automated system has fixed costs of $375,000 but that those costs could easily double in the first year and come back down in the second and third years as bugs are worked out of the system and workers learn to use it. Again, the spreadsheet can effortlessly handle the many computations.

A spreadsheet, while wonderful for cranking out numerical answers, cannot do the most difficult job in CVP analysis. That job is determining the data to be entered in the first place. The managerial accountant must be aware of the cost and price distributions of the firm as well as of the impact of changing economic conditions on these variables. The fact that variables are seldom known with certainty is no excuse for ignoring the impact of uncertainty on CVP analysis. Fortunately, sensitivity analysis can also give managers a feel for the degree to which a poorly forecast variable will affect an answer. That is also an advantage.

ETHICS It is important to note that the CVP results are only one input into business decisions. There are many other factors that may bear on decisions to choose one type of process over another, for example, or whether or not to delete certain costs. Businesses and nonprofit entities often face trade-offs involving safety. Ethical concerns also have an important place in CVP analysis. One possibility is that cost of potential problems can be estimated and included in the CVP results. Often, however, the costs and probabilities are not known with sufficient certainty. In that case, these factors are included in the ultimate decision-making process. Chapter 12, on short-run decision making, covers this topic in more detail.

## Summary of Learning Objectives

**LO1. Determine the break-even point in number of units and in total sales dollars.**
- At break even, total costs (variable and fixed) equal total sales revenue.
- Break-even units equal total fixed costs divided by the contribution margin (price minus variable cost per unit).
- Break-even revenue equals total fixed costs divided by the contribution margin ratio.

**LO2. Determine the number of units that must be sold, and the amount of revenue required, to earn a targeted profit.**
- To earn a target (desired) profit, total costs (variable and fixed) plus the amount of target profit must equal total sales revenue.
- Units to earn target profit equal total fixed costs plus target profit divided by the contribution margin.
- Sales revenue to earn target profit equals total fixed costs plus target profit divided by the contribution margin ratio.

**LO3. Prepare a profit-volume graph and a cost-volume-profit graph, and explain the meaning of each.**
- CVP assumes linear revenue and cost functions, no finished goods ending inventories, constant sales mix, and that selling prices and fixed and variable costs are known with certainty.
Summary of Important Equations

1. Sales revenue = Price × Units sold
2. Operating income = (Price × Units sold) – (Unit variable cost × Units sold) – Fixed cost
3. Break-even point in units = \( \frac{\text{Fixed cost}}{(\text{Price} - \text{Unit variable cost})} \)
4. Contribution margin ratio = \( \frac{\text{Total contribution margin}}{\text{Sales}} \)
   or
   \( = \frac{(\text{Price} - \text{Unit variable cost})}{\text{Price}} \)
5. Variable cost ratio = \( \frac{\text{Variable cost}}{\text{Sales}} \)
   or
   \( = \frac{\text{Unit variable cost}}{\text{Price}} \)
6. Break-even point in sales dollars = \( \frac{\text{Fixed cost}}{\text{Contribution margin ratio}} \)
   or
   \( = \frac{\text{Fixed cost}}{(1 - \text{Variable cost ratio})} \)
7. Margin of safety = Sales – Break-even sales
8. Degree of operating leverage = \( \frac{\text{Total contribution margin}}{\text{Operating income}} \)
9. Percentage change in profits = Degree of operating leverage × Percent change in sales

- Multiple-product analysis requires the expected sales mix.
- Break-even units for each product will change as the sales mix changes.
- Increased sales of high contribution margin products decrease the break-even point.
- Increased sales of low contribution margin products increase the break-even point.

LO5. Explain the impact of risk, uncertainty, and changing variables on cost-volume-profit analysis.
- Uncertainty regarding costs, prices, and sales mix affect the break-even point.
- Sensitivity analysis allows managers to vary costs, prices, and sales mix to show various possible break-even points.
- Margin of safety shows how far the company’s actual sales and/or units are above or below the break-even point.
- Operating leverage is the use of fixed costs to increase the percentage changes in profits as sales activity changes.
Review Problems

I. Single Product Cost-Volume-Profit Analysis

Cutlass Company’s projected profit for the coming year is as follows:

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Per Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>$200,000</td>
<td>$20</td>
</tr>
<tr>
<td>Less: Variable expenses</td>
<td>120,000</td>
<td>12</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$ 80,000</td>
<td>$ 8</td>
</tr>
<tr>
<td>Less: Fixed expenses</td>
<td>64,000</td>
<td></td>
</tr>
<tr>
<td>Operating income</td>
<td>$ 16,000</td>
<td></td>
</tr>
</tbody>
</table>
Chapter 4  Cost-Volume-Profit Analysis: A Managerial Planning Tool

**Required:**
1. Compute the variable cost ratio. Compute the contribution margin ratio.
2. Compute the break-even point in units.
3. Compute the break-even point in sales dollars.
4. How many units must be sold to earn a profit of $30,000?
5. Compute the contribution margin ratio. Using that ratio, compute the additional profit that Cutlass would earn if sales were $25,000 more than expected.
6. For the projected level of sales, compute the margin of safety in units and in sales dollars.
7. Calculate the degree of operating leverage. Now suppose that Cutlass revises the forecast to show a 30% increase in sales over the original forecast. What is the percent change in operating income expected for the revised forecast? What is the total operating income expected by Cutlass after revising the sales forecast?

**Solution:**
1. Variable cost ratio = \( \frac{\text{Total variable cost}}{\text{Sales}} \)
   \[ = \frac{\$120,000}{\$200,000} \]
   \[ = 0.60, \text{ or } 60\% \]

   Contribution margin ratio = \( \frac{\text{Contribution margin}}{\text{Sales}} \)
   \[ = \frac{\$80,000}{\$200,000} \]
   \[ = 0.40, \text{ or } 40\% \]

2. The break-even point is computed as follows:
   \[ \text{Units} = \frac{\text{Fixed cost}}{(\text{Price} - \text{Unit variable cost})} \]
   \[ = \frac{\$64,000}{($20 - $12)} \]
   \[ = \frac{\$64,000}{8} \]
   \[ = 8,000 \text{ units} \]

3. The break-even point in sales dollars is computed as follows:
   \[ \text{Break-even sales dollars} = \frac{\text{Fixed cost}}{\text{Contribution margin ratio}} \]
   \[ = \frac{\$64,000}{0.40} \]
   \[ = \$160,000 \]

4. The number of units that must be sold to earn a profit of $30,000 is calculated as follows:
   \[ \text{Units} = \frac{(\$64,000 + \$30,000)}{\$8} \]
   \[ = \frac{\$94,000}{\$8} \]
   \[ = 11,750 \text{ units} \]

5. The additional contribution margin on additional sales of $25,000 would be $0.40 \times \$25,000 = $10,000.

6. Margin of safety in units = Projected units – Break-even units
   \[ = 10,000 – 8,000 = 2,000 \text{ units} \]

   Margin of safety in sales dollars = $200,000 – $160,000 or $40,000 in sales revenues.

7. Degree of operating leverage = \( \frac{\text{Contribution margin}}{\text{Operating income}} \)
   \[ = \frac{\$80,000}{\$16,000} \]
   \[ = 5.0 \]
II. Multiple-Product Cost-Volume-Profit Analysis

Alpha Company produces and sells two products: Alpha-Basic and Alpha-Deluxe. In the coming year, Alpha expects to sell 3,000 units of Alpha-Basic and 1,500 units of Alpha-Deluxe. Information on the two products is as follows:

<table>
<thead>
<tr>
<th></th>
<th>Alpha-Basic</th>
<th>Alpha-Deluxe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>$120</td>
<td>$200</td>
</tr>
<tr>
<td>Variable cost per unit</td>
<td>40</td>
<td>80</td>
</tr>
</tbody>
</table>

Total fixed costs are $140,000.

**Required:**
1. What is the sales mix of Alpha-Basic to Alpha-Deluxe?
2. Compute the break-even quantity of each product.

**Solution:**
1. The sales mix of Alpha-Basic to Alpha-Deluxe is 3,000:1,500 or 2:1.
2. Each package consists of two Alpha-Basic and one Alpha-Deluxe:

<table>
<thead>
<tr>
<th>Product</th>
<th>Price</th>
<th>Variable Cost</th>
<th>Unit Contribution Margin</th>
<th>Sales Mix</th>
<th>Package Unit Contribution Margin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha-Basic</td>
<td>$120</td>
<td>$40</td>
<td>$80</td>
<td>2</td>
<td>$160</td>
</tr>
<tr>
<td>Alpha-Deluxe</td>
<td>200</td>
<td>80</td>
<td>120</td>
<td>1</td>
<td>120</td>
</tr>
<tr>
<td>Package total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$280</td>
</tr>
</tbody>
</table>

Break-even packages = \( \frac{\text{Total fixed cost}}{\text{Package contribution margin}} \)

\[= \frac{140,000}{280} \]

\[= 500 \text{ packages} \]

Alpha-Basic break-even units = \( 500 \times 2 = 1,000 \)

Alpha-Deluxe break-even units = \( 500 \times 1 = 500 \)

**Discussion Questions**

1. Explain how CVP analysis can be used for managerial planning.
2. Describe the difference between the units sold approach to CVP analysis and the sales revenue approach.
3. Define the term *break-even point*.
4. Explain why contribution margin per unit becomes profit per unit above the break-even point.
5. What is the variable cost ratio? The contribution margin ratio? How are the two ratios related?
6. Suppose a firm with a contribution margin ratio of 0.3 increased its advertising expenses by $10,000 and found that sales increased by $30,000. Was it a good
decision to increase advertising expenses? Suppose that the contribution margin ratio is now 0.4. Would it be a good decision to increase advertising expenses?

7. Define the term *sales mix*, and give an example to support your definition.

8. Explain how CVP analysis developed for single products can be used in a multiple-product setting.

9. Since break-even analysis focuses on making zero profit, it is of no value in determining the units a firm must sell to earn a targeted profit. Do you agree or disagree with this statement? Why?

10. How does targeted profit enter into the break-even units equation?

11. Explain how a change in sales mix can change a company’s break-even point.

12. Define the term *margin of safety*. Explain how it can be used as a crude measure of operating risk.

13. Explain what is meant by the term *operating leverage*. What impact does increased leverage have on risk?

14. How can sensitivity analysis be used in conjunction with CVP analysis?

15. Why is a declining margin of safety over a period of time an issue of concern to managers?

### Multiple-Choice Exercises

**4-1 If the variable cost per unit goes up,**

<table>
<thead>
<tr>
<th>Contribution margin</th>
<th>Break-even point</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. increases</td>
<td>increases</td>
</tr>
<tr>
<td>b. increases</td>
<td>decreases</td>
</tr>
<tr>
<td>c. decreases</td>
<td>decreases</td>
</tr>
<tr>
<td>d. decreases</td>
<td>increases</td>
</tr>
<tr>
<td>e. decreases</td>
<td>remains unchanged</td>
</tr>
</tbody>
</table>

**4-2 The amount of revenue required to earn a targeted profit is equal to**

- a. fixed cost divided by contribution margin.
- b. fixed cost divided by contribution margin ratio.
- c. fixed cost plus targeted profit divided by contribution margin ratio.
- d. targeted profit divided by contribution margin ratio.
- e. targeted profit divided by variable cost ratio.

**4-3 Break-even revenue for the multiple-product firm can**

- a. be calculated by dividing total fixed cost by the overall contribution margin ratio.
- b. be calculated by dividing segment fixed cost by the overall contribution margin ratio.
- c. be calculated by dividing total fixed cost by the package contribution margin.
- d. be calculated by multiplying total fixed cost by the contribution margin ratio.
- e. not be calculated; break-even revenue can only be computed for a single-product firm.

**4-4 In the cost-volume-profit graph,**

- a. the break-even point is found where the total revenue curve crosses the x-axis.
- b. the area of profit is to the left of the break-even point.
- c. the area of loss cannot be determined.
- d. both the total revenue curve and the total cost curve appear.
- e. neither the total revenue curve nor the total cost curve appear.

**4-5 An important assumption of cost-volume-profit analysis is that**

- a. both costs and revenues are linear functions.
- b. all cost and revenue relationships are analyzed within the relevant range.
c. there is no change in inventories.
d. sales mix remains constant.
e. all of the above are assumptions of cost-volume-profit analysis.

4-6 The use of fixed costs to extract higher percentage changes in profits as sales activity changes involves
a. margin of safety.
b. operating leverage.
c. degree of operating leverage.
d. sensitivity analysis.
e. variable cost reduction.

4-7 If the margin of safety is 0, then
a. the company is operating at a loss.
b. the company is precisely breaking even.
c. the company is earning a small profit.
d. the margin of safety cannot be less than or equal to 0; it must be positive.
e. none of the above is true.

4-8 The contribution margin is the
a. amount by which sales exceed fixed costs.
b. difference between sales and total expenses.
c. difference between sales and operating income.
d. difference between sales and total variable expense.
e. difference between variable expense and fixed expense.

Use the following information for 4-9 and 4-10.
Corleone Company produces a single product with a price of $15, variable costs per unit of $12, and fixed costs of $9,000.

4-9 Corleone’s break-even point in units
a. is 600.
b. is 750.
c. is 9,000.
d. is 3,000.
e. cannot be determined from the information given.

4-10 The variable cost ratio and the contribution margin ratio for Corleone are

<table>
<thead>
<tr>
<th>Variable cost ratio</th>
<th>Contribution margin ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>80%</td>
<td>80%</td>
</tr>
<tr>
<td>20%</td>
<td>80%</td>
</tr>
<tr>
<td>20%</td>
<td>20%</td>
</tr>
<tr>
<td>80%</td>
<td>20%</td>
</tr>
</tbody>
</table>

e. The contribution margin ratio cannot be determined from the information given.

4-11 If a company’s fixed costs rise by $10,000, which of the following will be true?

a. The break-even point will decrease.
b. The variable cost ratio will increase.
c. The break-even point will be unchanged.
d. The variable cost ratio will decrease.
e. The contribution margin ratio will be unchanged.
4-12 Solemon Company has fixed costs of $15,000, variable cost per unit of $5, and a price of $8. If Solemon wants to earn a targeted profit of $3,600, how many units must be sold?

a. 6,200
b. 5,000
c. 1,200
d. 3,720
e. 1,875

Cornerstone Exercises

Cornerstone Exercise 4-13 VARIABLE COST, FIXED COST, CONTRIBUTION MARGIN INCOME STATEMENT

Head-First Company plans to sell 5,000 bicycle helmets at $70 each in the coming year. Product costs include:

- Direct materials per helmet $ 30
- Direct labor per helmet 5
- Variable overhead per helmet 12
- Total fixed factory overhead 14,000

Variable selling expense is a commission of $2 per helmet; fixed selling and administrative expense totals $15,400.

Required:
1. Calculate the total variable cost per unit.
2. Calculate the total fixed expense for the year.
3. Prepare a contribution margin income statement for Head-First Company for the coming year.

Cornerstone Exercise 4-14 BREAK-EVEN POINT IN UNITS

Head-First Company plans to sell 5,000 bicycle helmets at $70 each in the coming year. Unit variable cost is $29 (includes direct materials, direct labor, variable overhead, and variable selling expense). Total fixed cost equals $29,400 (includes fixed factory overhead and fixed selling and administrative expense).

Required:
1. Calculate the break-even number of helmets.
2. Check your answer by preparing a contribution margin income statement based on the break-even units.

Cornerstone Exercise 4-15 VARIABLE COST RATIO; CONTRIBUTION MARGIN RATIO

Head-First Company plans to sell 5,000 bicycle helmets at $70 each in the coming year. Unit variable cost is $29 (includes direct materials, direct labor, variable overhead, and variable selling expense). Fixed factory overhead is $14,000 and fixed selling and administrative expense is $15,400.

Required:
1. Calculate the variable cost ratio.
2. Calculate the contribution margin cost ratio.
3. Prepare a contribution margin income statement based on the budgeted figures for next year. In a column next to the income statement, show the percentages based on sales for sales, total variable costs, and total contribution margin.
Cornerstone Exercise 4-16 BREAK-EVEN POINT IN SALES DOLLARS
Head-First Company plans to sell 5,000 bicycle helmets at $70 each in the coming year. Variable cost is 70 percent of the sales price; contribution margin is 30 percent of sales price. Total fixed cost equals $29,400 (includes fixed factory overhead and fixed selling and administrative expense).

Required:
1. Calculate the sales revenue that Head-First must make to break even by using the break-even point in sales equation.
2. Check your answer by preparing a contribution margin income statement based on the break-even point in sales dollars.

Cornerstone Exercise 4-17 UNITS TO EARN TARGET INCOME
Head-First Company plans to sell 5,000 bicycle helmets at $70 each in the coming year. Unit variable cost is $29 (includes direct materials, direct labor, variable overhead, and variable selling expense). Total fixed cost equals $29,400 (includes fixed factory overhead and fixed selling and administrative expense).

Required:
1. Calculate the number of helmets Head-First must sell to earn operating income of $81,900.
2. Check your answer by preparing a contribution margin income statement based on the number of units calculated.

Cornerstone Exercise 4-18 SALES NEEDED TO EARN TARGET INCOME
Head-First Company plans to sell 5,000 bicycle helmets at $70 each in the coming year. Variable cost is 70 percent of the sales price; contribution margin is 30 percent of sales price. Total fixed cost equals $29,400 (includes fixed factory overhead and fixed selling and administrative expense).

Required:
1. Calculate the sales revenue that Head-First must make to earn operating income of $81,900.
2. Check your answer by preparing a contribution margin income statement based on the sales dollars calculated in Requirement 1.

Cornerstone Exercise 4-19 BREAK-EVEN POINT IN UNITS FOR A MULTIPLE-PRODUCT FIRM
Suppose that Head-First Company now sells both bicycle helmets and motorcycle helmets. The bicycle helmets are priced at $70 and have variable costs of $29 each. The motorcycle helmets are priced at $220 and have variable costs of $143 each. Total fixed costs for Head-First as a whole equals $54,600 (includes all fixed factory overhead and fixed selling and administrative expense). Next year, Head-First expects to sell 5,000 bicycle helmets and 1,000 motorcycle helmets.

Required:
1. Form a package of bicycle and motorcycle helmets based on the sales mix expected for the coming year.
2. Calculate the break-even point in units for bicycle helmets and for motorcycle helmets.
3. Check your answer by preparing a contribution margin income statement.

Cornerstone Exercise 4-20 BREAK-EVEN SALES DOLLARS FOR A MULTIPLE-PRODUCT FIRM
Head-First Company now sells both bicycle helmets and motorcycle helmets. Next year, Head-First expects to produce total revenue of $570,000 and total variable costs of $388,000. Total fixed costs are expected to be $54,600.
Required:
1. Calculate the break-even point in sales dollars for Head-First. (Round the contribution margin ratio to four significant digits.)
2. Check your answer by preparing a contribution margin income statement.

**Cornerstone Exercise 4-21 MARGIN OF SAFETY**
Head-First Company plans to sell 5,000 bicycle helmets at $70 each in the coming year. Unit variable cost is $29 (includes direct materials, direct labor, variable overhead, and variable selling expense). Total fixed cost equals $29,400 (includes fixed factory overhead and fixed selling and administrative expense). Break-even units equal 1,400.

Required:
1. Calculate the margin of safety in terms of the number of units.
2. Calculate the margin of safety in terms of sales revenue.

**Cornerstone Exercise 4-22 DEGREE OF OPERATING LEVERAGE**
Head-First Company plans to sell 5,000 bicycle helmets at $70 each in the coming year. Unit variable cost is $29 (includes direct materials, direct labor, variable overhead, and variable selling expense). Total fixed cost equals $29,400 (includes fixed factory overhead and fixed selling and administrative expense). Operating income at 5,000 units sold is $75,600.

Required:
1. Calculate the degree of operating leverage. (Round your answer to the nearest tenth.)

**Cornerstone Exercise 4-23 IMPACT OF INCREASED SALES ON OPERATING INCOME USING THE DEGREE OF OPERATING LEVERAGE**
Head-First Company had planned to sell 5,000 bicycle helmets at $70 each in the coming year. Unit variable cost is $29 (includes direct materials, direct labor, variable overhead, and variable selling expense). Total fixed cost equals $29,400 (includes fixed factory overhead and fixed selling and administrative expense). Operating income at 5,000 units sold is $75,600. The degree of operating leverage is 1.4. Now Head-First expects to increase sales by 15 percent next year.

Required:
1. Calculate the percent change in operating income expected.
2. Calculate the operating income expected next year using the percent change in operating income calculated in Requirement 1.

**Exercises**

**Exercise 4-24 BASIC BREAK-EVEN CALCULATIONS**
Suppose that Adams Company sells a product for $16. Unit costs are as follows:

- Direct materials: $3.90
- Direct labor: $1.40
- Variable overhead: $2.10
- Variable selling and administrative expense: $1.60

Total fixed overhead is $52,000 per year, and total fixed selling and administrative expense is $37,950.

Required:
1. Calculate the variable cost per unit and the contribution margin per unit.
2. Calculate the contribution margin ratio and the variable cost ratio.
3. Calculate the break-even units.
4. Prepare a contribution margin income statement at the break-even number of units.

**Exercise 4-25 CONTRIBUTION MARGIN, CONTRIBUTION MARGIN RATIO, BREAK-EVEN POINT IN UNITS, BREAK-EVEN SALES REVENUE**

Next year, Jefferson Company expects to sell 140,000 units at $7.60 each. Variable costs are 60 percent of sales price. Fixed costs total $349,600.

**Required:**
1. Calculate the contribution margin per unit.
2. Calculate the break-even point in units.
3. Calculate the break-even sales revenue.
4. Prepare an income statement for Jefferson at break even.

**Exercise 4-26 CONTRIBUTION MARGIN RATIO, VARIABLE COST RATIO, BREAK-EVEN SALES REVENUE**

The controller of Sandoval Company prepared the following projected income statement:

<table>
<thead>
<tr>
<th>Sales</th>
<th>$90,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less: Variable costs</td>
<td>72,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$18,000</td>
</tr>
<tr>
<td>Less: Fixed costs</td>
<td>6,900</td>
</tr>
<tr>
<td>Operating income</td>
<td>$11,100</td>
</tr>
</tbody>
</table>

**Required:**
1. Calculate the contribution margin ratio.
2. Calculate the variable cost ratio.
3. Calculate the break-even sales revenue for Sandoval.

**Exercise 4-27 INCOME STATEMENT, BREAK-EVEN UNITS, UNITS TO EARN TARGET INCOME**

Goslin Company sold 27,000 units last year at $14 each. Variable cost was $9.50, and fixed costs were $126,000.

**Required:**
1. Prepare an income statement for Goslin Company for last year.
2. Calculate the break-even point in units.
3. Calculate the units that Goslin must sell to earn operating income of $9,900 next year.

**Exercise 4-28 UNITS SOLD TO BREAK EVEN, UNIT VARIABLE COST, UNIT MANUFACTURING COST, UNITS TO EARN TARGET INCOME**

Prachi Company produces and sells disposable foil baking pans to retailers for $2.45 per pan. The variable costs per pan are as follows:

- Direct materials: $0.27
- Direct labor: 0.58
- Variable overhead: 0.63
- Variable selling: 0.17

Fixed manufacturing costs total $131,650 per year. Administrative costs (all fixed) total $18,350.

**Required:**
1. Compute the number of pans that must be sold for Prachi to break even.
2. What is the unit variable cost? What is the unit variable manufacturing cost? Which is used in cost-volume-profit analysis and why?
3. How many pans must be sold for Prachi to earn operating income of $12,600?
4. How much sales revenue must Prachi have to earn operating income of $12,600?

**OBJECTIVE 5**

**Exercise 4-29 MARGIN OF SAFETY**

Chase Company produces and sells strings of colorful indoor/outdoor lights for holiday display to retailers for $6.28 per string. The variable costs per string are as follows:

- Direct materials $1.27
- Direct labor 1.58
- Variable overhead 0.63
- Variable selling 0.17

Fixed manufacturing costs total $231,650 per year. Administrative costs (all fixed) total $315,390. Chase expects to sell 380,000 strings of light next year.

**Required:**
1. Calculate the break-even point in units.
2. Calculate the margin of safety in units.
3. Calculate the margin of safety in dollars.

**OBJECTIVE 1**

**Exercise 4-30 CONTRIBUTION MARGIN, UNIT AMOUNTS, BREAK-EVEN UNITS**

Information on four independent companies follows. Calculate the correct amount for each question mark. (Round your answers to two significant digits.)

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>$15,000</td>
<td>$</td>
<td>$</td>
</tr>
<tr>
<td>Total variable costs</td>
<td>5,000</td>
<td>11,700</td>
<td>9,750</td>
</tr>
<tr>
<td>Total contribution margin</td>
<td>$10,000</td>
<td>$3,900</td>
<td>$</td>
</tr>
<tr>
<td>Total fixed costs</td>
<td>?</td>
<td>4,000</td>
<td>?</td>
</tr>
<tr>
<td>Operating income (loss)</td>
<td>$500</td>
<td>$</td>
<td>$364</td>
</tr>
<tr>
<td>Units sold</td>
<td>?</td>
<td>1,300</td>
<td>125</td>
</tr>
<tr>
<td>Price per unit</td>
<td>$5.00</td>
<td>?</td>
<td>$130</td>
</tr>
<tr>
<td>Variable cost per unit</td>
<td>?</td>
<td>$9</td>
<td>?</td>
</tr>
<tr>
<td>Contribution margin per unit</td>
<td>?</td>
<td>$3</td>
<td>?</td>
</tr>
<tr>
<td>Contribution margin ratio</td>
<td>?</td>
<td>?</td>
<td>40%</td>
</tr>
<tr>
<td>Break even in units</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
</tbody>
</table>

**OBJECTIVE 1 2 5**

**Exercise 4-31 SALES REVENUE APPROACH, VARIABLE COST RATIO, CONTRIBUTION MARGIN RATIO**

Rezler Company’s controller prepared the following budgeted income statement for the coming year:

Sales $315,000
Less: Variable expenses 141,750
Contribution margin $173,250
Less: Fixed expenses 63,000
Operating income $110,250

**Required:**
1. What is Rezler’s variable cost ratio? What is its contribution margin ratio?
2. Suppose Rezler’s actual revenues are $30,000 more than budgeted. By how much will operating income increase? Give the answer without preparing a new income statement.
3. How much sales revenue must Rezler earn to break even? Prepare a contribution margin income statement to verify the accuracy of your answer.
4. What is Rezler’s expected margin of safety?
5. What is Rezler’s margin of safety if sales revenue is $280,000?
Exercise 4-32 MULTIPLE-PRODUCT BREAK EVEN

Switzer Company produces and sells yoga-training products: how-to DVDs and a basic equipment set (blocks, strap, and small pillows). Last year, Switzer sold 10,000 DVDs and 5,000 equipment sets. Information on the two products is as follows:

<table>
<thead>
<tr>
<th></th>
<th>DVDs</th>
<th>Equipment Sets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>$12</td>
<td>$15</td>
</tr>
<tr>
<td>Variable cost per unit</td>
<td>4</td>
<td>6</td>
</tr>
</tbody>
</table>

Total fixed costs are $70,000.

Required:
1. What is the sales mix of DVDs and equipment sets?
2. Compute the break-even quantity of each product.

Exercise 4-33 MULTIPLE-PRODUCT BREAK EVEN, BREAK-EVEN SALES REVENUE

Refer to the data in Exercise 4-32. Suppose that in the coming year, Switzer plans to produce an extra-thick yoga mat for sale to health clubs. The company estimates that 20,000 mats can be sold at a price of $18 and a variable cost per unit of $13. Fixed costs must be increased by $48,350 (making total fixed costs of $118,350). Assume that anticipated sales of the other products, as well as their prices and variable costs, remain the same.

Required:
1. What is the sales mix of DVDs, equipment sets, and yoga mats?
2. Compute the break-even quantity of each product.
3. Prepare an income statement for Switzer for the coming year. What is the overall contribution margin ratio? The overall break-even sales revenue?
4. Compute the margin of safety for the coming year in sales dollars. (Round the contribution margin ratio to three significant digits; round the break-even sales revenue to the nearest dollar.)

Exercise 4-34 CONTRIBUTION MARGIN RATIO, BREAK-EVEN SALES REVENUE, AND MARGIN OF SAFETY FOR MULTIPLE-PRODUCT FIRM

Sonora Company produces and sells pottery chimineas (small clay outdoor fireplaces). The chimineas come in three models: small basic, large basic, and carved (ornately shaped and carved). In the coming year, Sonora sold 30,000 small basic models, 50,000 large basic models, and 10,000 carved models. Information on the three models is as follows:

<table>
<thead>
<tr>
<th></th>
<th>Small</th>
<th>Large</th>
<th>Carved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>$120</td>
<td>$200</td>
<td>$350</td>
</tr>
<tr>
<td>Variable cost per unit</td>
<td>70</td>
<td>150</td>
<td>275</td>
</tr>
</tbody>
</table>

Total fixed costs are $446,500.

Required:
1. What is the sales mix of small basic to large basic to carved models?
2. Compute the break-even quantity of each product.
3. Prepare an income statement for Sonora for the coming year. What is the overall contribution margin ratio? The overall break-even sales revenue?
4. Compute the margin of safety for the coming year.

Exercise 4-35 COST-VOLUME-PROFIT GRAPHS

Lotts Company produces and sells one product. The selling price is $10, and the unit variable cost is $6. Total fixed costs are $10,000.

Required:
1. Prepare a CVP graph with “Units Sold” as the horizontal axis and “$ Profit” as the vertical axis. Label the break-even point on the horizontal axis.
2. Prepare CVP graphs for each of the following independent scenarios:
   a. Fixed costs increase by $5,000.
   b. Unit variable cost increases to $7.
   c. Unit selling price increases to $12.
   d. Assume that fixed costs increase by $5,000 and unit variable cost is $7.

**OBJECTIVE > 1**

**Exercise 4-36 BASIC COST-VOLUME-PROFIT CONCEPTS**

Berry Company produces a single product. The projected income statement for the coming year is as follows:

- Sales (18,000 units @ $60) $1,080,000
- Less: Variable costs $594,000
- Contribution margin $486,000
- Less: Fixed costs $540,000
- Operating income $(54,000)

**Required:**

1. Compute the unit contribution margin and the units that must be sold to break even.
2. Suppose 30,000 units are sold above break even. What is the operating income?
3. Compute the contribution margin ratio and the break-even point in dollars. Suppose that revenues are $200,000 more than expected for the coming year. What would the total operating income be?

**OBJECTIVE > 1**

**Exercise 4-37 MARGIN OF SAFETY AND OPERATING LEVERAGE**

Agador Company produces a single product. The projected income statement for the coming year is as follows:

- Sales (50,000 units @ $45) $2,250,000
- Less: Variable costs $945,000
- Contribution margin $1,305,000
- Less: Fixed costs $916,650
- Operating income $388,350

(Round all dollar answers to the nearest dollar. Round fractional answers to two significant digits.)

**Required:**

1. Compute the break-even sales dollars.
2. Compute the margin of safety in sales dollars.
3. Compute the degree of operating leverage (rounded to two decimal places).
4. Compute the new profit level if sales are 20 percent higher than expected. (Round to the nearest dollar.)

**OBJECTIVE > 1**

**Exercise 4-38 MULTIPLE-PRODUCT BREAK EVEN**

Parker Pottery produces a line of vases and a line of ceramic figurines. Each line uses the same equipment and labor; hence, there are no traceable fixed costs. Common fixed costs equal $30,000. Parker’s accountant has begun to assess the profitability of the two lines and has gathered the following data for last year:

<table>
<thead>
<tr>
<th></th>
<th>Vases</th>
<th>Figurines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>$40</td>
<td>$70</td>
</tr>
<tr>
<td>Variable cost</td>
<td>30</td>
<td>42</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$10</td>
<td>$28</td>
</tr>
<tr>
<td>Number of units</td>
<td>1,000</td>
<td>500</td>
</tr>
</tbody>
</table>

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Required:
1. Compute the number of vases and the number of figurines that must be sold for the company to break even.
2. Parker Pottery is considering upgrading its factory to improve the quality of its products. The upgrade will add $5,260 per year to total fixed costs. If the upgrade is successful, the projected sales of vases will be 1,500, and figurine sales will increase to 1,000 units. What is the new break-even point in units for each of the products?

Exercise 4-39 BREAK-EVEN UNITS, CONTRIBUTION MARGIN RATIO, MULTIPLE-PRODUCT BREAK EVEN, MARGIN OF SAFETY, DEGREE OF OPERATING LEVERAGE

Rad-Brad, Inc.’s projected operating income (based on sales of 350,000 units) for the coming year is as follows:

<table>
<thead>
<tr>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
</tr>
<tr>
<td>Less: Variable expenses</td>
</tr>
<tr>
<td>Contribution margin</td>
</tr>
<tr>
<td>Less: Fixed expenses</td>
</tr>
<tr>
<td>Operating income</td>
</tr>
</tbody>
</table>

Required:
1. Compute:
   a. Variable cost per unit
   b. Contribution margin per unit
   c. Contribution margin ratio
   d. Break-even point in units.
   e. Break-even point in sales dollars.
2. How many units must be sold to earn operating income of $300,000?
3. Compute the additional operating income that Rad-Brad’s would earn if sales were $50,000 more than expected.
4. For the projected level of sales, compute the margin of safety in units, and then in sales dollars.
5. Compute the degree of operating leverage.
6. Compute the new profit level if sales are 10 percent higher than expected.

Problems

Problem 4-40 BREAK-EVEN UNITS, CONTRIBUTION MARGIN RATIO, MARGIN OF SAFETY

Bandaleria Company’s projected profit for the coming year is as follows:

<table>
<thead>
<tr>
<th>Total</th>
<th>Per Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>$2,480,000</td>
</tr>
<tr>
<td>Less: Variable expenses</td>
<td>1,488,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$ 992,000</td>
</tr>
<tr>
<td>Less: Fixed expenses</td>
<td>716,800</td>
</tr>
<tr>
<td>Operating income</td>
<td>$ 275,200</td>
</tr>
</tbody>
</table>

Required:
1. Compute the break-even point in units.
2. How many units must be sold to earn a profit of $640,000?
3. Compute the contribution margin ratio. Using that ratio, compute the additional profit that Bandaleria would earn if sales were $50,000 more than expected.
4. For the projected level of sales, compute the margin of safety in units.
Problem 4-41 BREAK-EVEN UNITS, OPERATING INCOME, MARGIN OF SAFETY

Dory Manufacturing Company produces T-shirts screen-printed with the logos of various sports teams. Each shirt is priced at $10 and has a unit variable cost of $5. Total fixed costs are $96,000.

Required:

1. Compute the break-even point in units.
2. Suppose that Dory could reduce its fixed costs by $13,500 by reducing the amount of setup and engineering time needed. How many units must be sold to break even in this case?
3. How does the reduction in fixed costs affect the break-even point? Operating income? The margin of safety?

Problem 4-42 CONTRIBUTION MARGIN, BREAK-EVEN UNITS, BREAK-EVEN SALES, MARGIN OF SAFETY, DEGREE OF OPERATING LEVERAGE

Sohrwide Company produces a variety of chemicals. One division makes reagents for laboratories. The division’s projected income statement for the coming year is:

<table>
<thead>
<tr>
<th>Sales (128,000 units @ $50)</th>
<th>$6,400,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less: Variable expenses</td>
<td>4,480,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$1,920,000</td>
</tr>
<tr>
<td>Less: Fixed expenses</td>
<td>1,000,000</td>
</tr>
<tr>
<td>Operating income</td>
<td>$ 920,000</td>
</tr>
</tbody>
</table>

Required:

1. Compute the contribution margin per unit, and calculate the break-even point in units (round to the nearest unit). Calculate the contribution margin ratio and the break-even sales revenue.
2. The divisional manager has decided to increase the advertising budget by $100,000. This will increase sales revenues by $1 million. By how much will operating income increase or decrease as a result of this action?
3. Suppose sales revenues exceed the estimated amount on the income statement by $315,000. Without preparing a new income statement, by how much are profits underestimated?
4. Compute the margin of safety based on the original income statement.
5. Compute the degree of operating leverage based on the original income statement. If sales revenues are 20 percent greater than expected, what is the percentage increase in profits?

Problem 4-43 MULTIPLE-PRODUCT ANALYSIS, CHANGES IN SALES MIX, SALES TO EARN TARGET OPERATING INCOME

Gosnell Company produces two products: squares and circles. The projected income for the coming year, segmented by product line, follows:

<table>
<thead>
<tr>
<th></th>
<th>Squares</th>
<th>Circles</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>$300,000</td>
<td>$2,500,000</td>
<td>$2,800,000</td>
</tr>
<tr>
<td>Less: Variable expenses</td>
<td>100,000</td>
<td>500,000</td>
<td>600,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$200,000</td>
<td>$2,000,000</td>
<td>$2,200,000</td>
</tr>
<tr>
<td>Less: Direct fixed expenses</td>
<td>28,000</td>
<td>1,500,000</td>
<td>1,528,000</td>
</tr>
<tr>
<td>Product margin</td>
<td>$172,000</td>
<td>$ 500,000</td>
<td>$ 672,000</td>
</tr>
<tr>
<td>Less: Common fixed expenses</td>
<td></td>
<td>100,000</td>
<td></td>
</tr>
<tr>
<td>Operating income</td>
<td></td>
<td></td>
<td>$ 572,000</td>
</tr>
</tbody>
</table>

The selling prices are $30 for squares and $50 for circles.
**Problem 4-44** COST-VOLUME-PROFIT EQUATION, BASIC CONCEPTS, SOLVING FOR UNKNOWNS

Nutri-Tress Company produces combination shampoos and conditioners in individual-use bottles for hotels. Each bottle sells for $0.36. The variable costs for each bottle (materials, labor, and overhead) total $0.27. The total fixed costs are $58,500. During the most recent year, 830,000 bottles were sold.

**Required:**
1. What is the break-even point in units for Nutri-Tress? What is the margin of safety in units for the most recent year?
2. Prepare an income statement for Nutri-Tress’s most recent year.
3. How many units must be sold for Nutri-Tress to earn a profit of $36,000?
4. What is the level of sales dollars needed for Nutri-Tress to earn operating income of 20 percent of sales?
The owner of Carlyle estimates that 60 percent of the sales revenues will be produced by floor lamps and the remaining 40 percent by desk lamps. Floor lamps are also responsible for 60 percent of the variable expenses. Of the fixed expenses, one-third are common to both products, and one-half are directly traceable to the floor lamp product line.

**Required:**
1. Compute the sales revenue that must be earned for Carlyle to break even.
2. Compute the number of floor lamps and desk lamps that must be sold for Carlyle to break even.
3. Compute the degree of operating leverage for Carlyle Lighting Products. Now assume that the actual revenues will be 40 percent higher than the projected revenues. By what percentage will profits increase with this change in sales volume?

**Problem 4-47 MULTIPLE-PRODUCT BREAK EVEN**

Polaris Inc. manufactures two types of metal stampings for the automobile industry: door handles and trim kits. Fixed costs equal $146,000. Each door handle sells for $12 and has variable costs of $9; each trim kit sells for $8 and has variable costs of $5.

**Required:**
1. What are the contribution margin per unit and the contribution margin ratio for door handles and for trim kits?
2. If Polaris sells 20,000 door handles and 40,000 trim kits, what is the operating income?
3. How many door handles and how many trim kits must be sold for Polaris to break even?
4. Assume that Polaris has the opportunity to rearrange its plant to produce only trim kits. If this is done, fixed costs will decrease by $35,000, and 70,000 trim kits can be produced and sold. Is this a good idea? Explain.

**Problem 4-48 COST-VOLUME-PROFIT, MARGIN OF SAFETY**

Victoria Company produces a single product. Last year’s income statement is as follows:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (29,000 units)</td>
<td>$1,218,000</td>
</tr>
<tr>
<td>Less: Variable costs</td>
<td>812,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$ 406,000</td>
</tr>
<tr>
<td>Less: Fixed costs</td>
<td>300,000</td>
</tr>
<tr>
<td>Operating income</td>
<td>$ 106,000</td>
</tr>
</tbody>
</table>

**Required:**
1. Compute the break-even point in units and sales dollars.
2. What was the margin of safety for Victoria Company last year?
3. Suppose that Victoria Company is considering an investment in new technology that will increase fixed costs by $250,000 per year but will lower variable costs to 45 percent of sales. Units sold will remain unchanged. Prepare a budgeted income statement assuming that Victoria makes this investment. What is the new break-even point in units and sales dollars, assuming that the investment is made?

**Problem 4-49 COST-VOLUME-PROFIT, MARGIN OF SAFETY**

Isaac Company had revenues of $930,000 last year with total variable costs of $353,400 and fixed costs of $310,000.
Required:
1. What is the variable cost ratio for Isaac? What is the contribution margin ratio?
2. What is the break-even point in sales revenue?
3. What was the margin of safety for Isaac last year?
4. Isaac is considering starting a multimedia advertising campaign that is supposed to increase sales by $7,500 per year. The campaign will cost $5,000. Is the advertising campaign a good idea? Explain.

Problem 4-50 USING THE BREAK-EVEN EQUATIONS TO SOLVE FOR PRICE AND VARIABLE COST PER UNIT

Solve the following independent problems.

Required:
1. Sarah Company’s break-even point is 1,500 units. Variable cost per unit is $300; total fixed costs are $120,000 per year. What price does Sarah charge?
2. Jesper Company charges a price of $3.50; total fixed costs are $160,000 per year, and the break-even point is 128,000 units. What is the variable cost per unit?

Problem 4-51 CONTRIBUTION MARGIN, COST-VOLUME-PROFIT, MARGIN OF SAFETY

Candyland Inc. produces a particularly rich praline fudge. Each 10-ounce box sells for $5.60. Variable unit costs are as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pecans</td>
<td>$0.70</td>
</tr>
<tr>
<td>Sugar</td>
<td>0.35</td>
</tr>
<tr>
<td>Butter</td>
<td>1.85</td>
</tr>
<tr>
<td>Other ingredients</td>
<td>0.34</td>
</tr>
<tr>
<td>Box, packing material</td>
<td>0.76</td>
</tr>
<tr>
<td>Selling commission</td>
<td>0.20</td>
</tr>
</tbody>
</table>

Fixed overhead cost is $32,300 per year. Fixed selling and administrative costs are $12,500 per year. Candyland sold 35,000 boxes last year.

Required:
1. What is the contribution margin per unit for a box of praline fudge? What is the contribution margin ratio?
2. How many boxes must be sold to break even? What is the break-even sales revenue?
3. What was Candyland’s operating income last year?
4. What was the margin of safety?
5. Suppose that Candyland Inc. raises the price to $6.20 per box but anticipates a sales drop to 31,500 boxes. What will be the new break-even point in units? Should Candyland raise the price? Explain.

Problem 4-52 BREAK-EVEN SALES, OPERATING LEVERAGE, CHANGE IN INCOME

Income statements for two different companies in the same industry are as follows:

<table>
<thead>
<tr>
<th>Company</th>
<th>Sales</th>
<th>Less: Variable costs</th>
<th>Contribution margin</th>
<th>Less: Fixed costs</th>
<th>Operating income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company A</td>
<td>$500,000</td>
<td>400,000</td>
<td>$100,000</td>
<td>50,000</td>
<td>$50,000</td>
</tr>
<tr>
<td>Company B</td>
<td>$500,000</td>
<td>200,000</td>
<td>$300,000</td>
<td>250,000</td>
<td>$50,000</td>
</tr>
</tbody>
</table>

Required:
1. Compute the degree of operating leverage for each company.
2. Compute the break-even point for each company. Explain why the break-even point for Company B is higher.
3. Suppose that both companies experience a 50 percent increase in revenues. Compute the percentage change in profits for each company. Explain why the percentage increase in Company B’s profits is so much larger than that of Company A.

**Problem 4-53 CONTRIBUTION MARGIN, BREAK-EVEN SALES, MARGIN OF SAFETY**

Suppose that Kicker had the following sales and cost experience (in thousands of dollars) for May of the current year and for May of the prior year:

<table>
<thead>
<tr>
<th></th>
<th>May, Current Year</th>
<th>May, Prior Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total sales</td>
<td>$ 43,560</td>
<td>$ 41,700</td>
</tr>
<tr>
<td>Less:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purchase price paid</td>
<td>(17,000)</td>
<td>(16,000)</td>
</tr>
<tr>
<td>Additional labor and supplies</td>
<td>(1,400)</td>
<td>(1,200)</td>
</tr>
<tr>
<td>Commissions</td>
<td>(1,250)</td>
<td>(1,100)</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$ 23,910</td>
<td>$ 23,400</td>
</tr>
<tr>
<td>Less:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixed warehouse cost</td>
<td>(680)</td>
<td>(500)</td>
</tr>
<tr>
<td>Fixed administrative cost</td>
<td>(4,300)</td>
<td>(4,300)</td>
</tr>
<tr>
<td>Fixed selling cost</td>
<td>(5,600)</td>
<td>(5,000)</td>
</tr>
<tr>
<td>Research and development</td>
<td>(9,750)</td>
<td>(4,000)</td>
</tr>
<tr>
<td>Operating income</td>
<td>$ 3,580</td>
<td>$ 9,600</td>
</tr>
</tbody>
</table>

In August of the prior year, Kicker started an intensive quality program designed to enable it to build original equipment manufacture (OEM) speaker systems for a major automobile company. The program was housed in research and development. In the beginning of the current year, Kicker’s accounting department exercised tighter control over sales commissions, ensuring that no dubious (e.g., double) payments were made. The increased sales in the current year required additional warehouse space that Kicker rented in town.

**Required:**
1. Calculate the contribution margin ratio for May of both years.
2. Calculate the break-even point in sales dollars for both years.
3. Calculate the margin of safety in sales dollars for both years.
4. Analyze the differences shown by your calculations in Requirements 1, 2, and 3.

**Cases**

**Case 4-54 COST-VOLUME-PROFIT WITH MULTIPLE PRODUCTS, SALES MIX CHANGES, CHANGES IN FIXED AND VARIABLE COSTS**

Artistic Woodcrafting Inc. began several years ago as a one-person cabinet-making operation. Employees were added as the business expanded. Last year, sales volume totaled $850,000. Volume for the first five months of the current year totaled $600,000, and sales were expected to be $1.6 million for the entire year. Unfortunately, the cabinet business in the region where Artistic Woodcrafting is located is highly competitive. More than 200 cabinet shops are all competing for the same business.

Artistic currently offers two different quality grades of cabinets: Grade I and Grade II, with Grade I being the higher quality. The average unit selling prices, unit variable costs, and direct fixed costs are as follows:

<table>
<thead>
<tr>
<th></th>
<th>Unit Price</th>
<th>Unit Variable Cost</th>
<th>Direct Fixed Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade I</td>
<td>$3,400</td>
<td>$2,686</td>
<td>$95,000</td>
</tr>
<tr>
<td>Grade II</td>
<td>1,600</td>
<td>1,328</td>
<td>95,000</td>
</tr>
</tbody>
</table>
Common fixed costs (fixed costs not traceable to either cabinet) are $35,000. Currently, for every three Grade I cabinets sold, seven Grade II cabinets are sold.

**Required:**
1. Calculate the number of Grade I and Grade II cabinets that are expected to be sold during the current year.
2. Calculate the number of Grade I and Grade II cabinets that must be sold for the company to break even.
3. Artistic Woodcrafting can buy computer-controlled machines that will make doors, drawers, and frames. If the machines are purchased, the variable costs for each type of cabinet will decrease by 9 percent, but common fixed costs will increase by $44,000. Compute the effect on operating income, and also calculate the new break-even point. Assume the machines are purchased at the beginning of the sixth month. Fixed costs for the company are incurred uniformly throughout the year.
4. Refer to the original data. Artistic Woodcrafting is considering adding a retail outlet. This will increase common fixed costs by $70,000 per year. As a result of adding the retail outlet, the additional publicity and emphasis on quality will allow the firm to change the sales mix to 1:1. The retail outlet is also expected to increase sales by 30 percent. Assume that the outlet is opened at the beginning of the sixth month. Calculate the effect on the company’s expected profits for the current year, and calculate the new break-even point. Assume that fixed costs are incurred uniformly throughout the year.

**Case 4-55 ETHICS AND A COST-VOLUME-ProFIT APPLICATION**

Danna Lumus, the marketing manager for a division that produces a variety of paper products, is considering the divisional manager’s request for a sales forecast for a new line of paper napkins. The divisional manager has been gathering data so that he can choose between two different production processes. The first process would have a variable cost of $10 per case produced and fixed costs of $100,000. The second process would have a variable cost of $6 per case and fixed costs of $200,000. The selling price would be $30 per case. Danna had just completed a marketing analysis that projects annual sales of 30,000 cases.

Danna is reluctant to report the 30,000 forecast to the divisional manager. She knows that the first process would be labor intensive, whereas the second would be largely automated with little labor and no requirement for an additional production supervisor. If the first process is chosen, Jerry Johnson, a good friend, will be appointed as the line supervisor. If the second process is chosen, Jerry and an entire line of laborers will be laid off. After some consideration, Danna revises the projected sales downward to 22,000 cases.

She believes that the revision downward is justified. Since it will lead the divisional manager to choose the manual system, it shows a sensitivity to the needs of current employees—a sensitivity that she is afraid her divisional manager does not possess. He is too focused on quantitative factors in his decision making and usually ignores the qualitative aspects.

**Required:**
1. Compute the break-even point for each process.
2. Compute the sales volume for which the two processes are equally profitable. Identify the range of sales for which the manual process is more profitable than the automated process. Identify the range of sales for which the automated process is more profitable than the manual process. Why does the divisional manager want the sales forecast?
3. Discuss Danna’s decision to alter the sales forecast. Do you agree with it? Is she acting ethically? Is her decision justified since it helps a number of employees retain their employment? Should the impact on employees be factored into decisions? In fact, is it unethical not to consider the impact of decisions on employees?