Regression analysis

\[ YYY = 703 + (1,442.97 \times 400 \text{ units}) = 703 + 577,188 = 577,891 \]

The account analysis ($578,428), scattergraph method ($580,756), and regression analysis ($577,891) all yield similar estimated production costs. The high-low method varies significantly from the other three approaches, likely because only two data points are used to estimate unit variable cost and total fixed costs.

### 5.3 The Contribution Margin Income Statement

**Learning Objective**

1. Prepare a contribution margin income statement.

After further work with her staff, Susan was able to break down the selling and administrative costs into their variable and fixed components. (This process is the same as the one we discussed earlier for production costs.) Susan then established the cost equations shown in Table 5.5.

| Table 5.5 Cost Equations for Bikes Unlimited |
|-----------------|-----------------------------------------------|
| **Production costs** | \( Y = 43,276 + 53.42X \) |
| **Selling and administrative costs** | \( Y = 110,000 + 9.00X \) |

**Question:** The challenge now is to organize this information in a way that is helpful to management—specifically, to Eric Mendez. The traditional income statement format used for external financial reporting simply breaks costs down by functional area: cost of goods sold and selling and administrative costs. **It does not show fixed and variable costs.** Panel A of illustrates the traditional format. (We defer consideration of income taxes to the end of.) How can this information be presented in an income statement that shows fixed and variable costs separately?

**Answer:** Another income statement format, called the contribution margin income statement, shows the fixed and variable components of cost information. This type of statement appears in
panel B of. Note that operating profit is the same in both statements, but the organization of data differs. The contribution margin income statement organizes the data in a way that makes it easier for management to assess how changes in production and sales will affect operating profit. The contribution margin represents sales revenue left over after deducting variable costs from sales. It is the amount remaining that will contribute to covering fixed costs and to operating profit (hence, the name contribution margin).

Eric indicated that sales volume in August could increase by 20 percent over sales in June of 5,000 units, which would increase unit sales to 6,000 units \([= 5,000 \text{ units} + (5,000 \times 20 \text{ percent})]\), and he asked Susan to come up with projected profit for August. Eric also mentioned that the sales price would remain the same at $100 per unit. Using this information and the cost estimate equations in Figure 5.7, Susan prepared the contribution margin income statement in panel B of Figure 5.7. Assume for now that 6,000 units is just within the relevant range for Bikes Unlimited. (We will discuss this assumption later in the chapter.)
The contribution margin income statement shown in panel B of clearly indicates which costs are variable and which are fixed. Recall that the variable cost per unit remains constant, and variable costs in total change in proportion to changes in activity. Because 6,000 units are expected to be sold in August, total variable costs are calculated by multiplying 6,000 units by the cost per unit ($53.42 per unit for cost of goods sold, and $9.00 per unit for selling and administrative costs). Thus total variable cost of goods sold is $320,520, and total variable selling and administrative costs are $54,000. These two amounts are combined to calculate total variable costs of $374,520, as shown in panel B of.

The contribution margin of $225,480 represents the sales revenue left over after deducting variable costs from sales ($225,480 = $600,000 – $374,520). It is the amount remaining that will contribute to covering fixed costs and to operating profit.

Recall that total fixed costs remain constant regardless of the level of activity. Thus fixed cost of goods sold remains at $43,276, and fixed selling and administrative costs stay at $110,000. This
holds true at both the 5,000 unit level of activity for June, and the 6,000 unit level of activity projected for August. Total fixed costs of $153,276 (= $43,276 + $110,000) are deducted from the contribution margin to calculate operating profit of $72,204.

Armed with this information, Susan meets with Eric the next day. Refer to panel B of as you read Susan’s comments about the contribution margin income statement.

<table>
<thead>
<tr>
<th>Susan:</th>
<th>Eric, I have some numbers for you. My projection for August is complete, and I expect profit to be approximately $72,000 if sales volume increases 20 percent.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eric:</td>
<td>Excellent! You were correct in figuring that profit would increase at a higher rate than sales because of our fixed costs.</td>
</tr>
<tr>
<td>Susan:</td>
<td>Here’s a copy of our projected income for August. This income statement format provides the variable and fixed costs. As you can see, our monthly fixed costs total approximately $153,000. Now that we have this information, we can easily make projections for different scenarios.</td>
</tr>
<tr>
<td>Eric:</td>
<td>This will be very helpful in making projections for future months. I’ll take your August projections to the management group this afternoon. Thanks for your help!</td>
</tr>
</tbody>
</table>

Business in Action 5.3

Source: [http://commons.wikimedia.org/wiki/File:LowesMeyerlandHoustonTX.jpg](http://commons.wikimedia.org/wiki/File:LowesMeyerlandHoustonTX.jpg)
Costs at **Lowe's Companies, Inc.**

**Lowe’s** is the world’s second largest home improvement retailer with more than 1,700 stores in the United States, Canada, and Mexico. The company has 234,000 employees. The following financial information is from **Lowe’s** income statement for the year ended January 28, 2011 (amounts are in millions). Which of the company’s costs are likely to be variable?

Variable costs probably include cost of sales (the cost of goods sold) and a portion of selling and general and administrative costs (e.g., the cost of hourly labor). Cost of sales alone represents 65 percent of net sales (rounded). Retail companies like **Lowe’s** tend to have higher variable costs than manufacturing companies like **General Motors** and **Boeing**.

Source: **Lowe’s** Web site (http://www.lowes.com).

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**KEY TAKEAWAY**

- The contribution margin income statement shows fixed and variable components of cost information. Revenue minus variable costs equals the contribution margin. The contribution margin minus fixed costs equals operating profit. This statement provides a clearer picture of which costs change and which costs remain the same with changes in levels of activity.

**REVIEW PROBLEM 5.7**

Last month, Alta Production, Inc., sold its product for $2,500 per unit. Fixed production costs were $3,000, and variable production costs amounted to $1,400 per unit. Fixed selling and administrative costs totaled $50,000, and variable selling and administrative costs amounted to $200 per unit. Alta Production produced and sold 400 units last month.

Prepare a traditional income statement and a contribution margin income statement for Alta Production. Use Figure 5.7 "Traditional and Contribution Margin Income Statements for Bikes Unlimited" as a guide.
6.1 Cost-Volume-Profit Analysis for Single-Product Companies

**LEARNING OBJECTIVE**

1. Perform cost-volume-profit analysis for single-product companies.

**Question:** The profit equation shows that profit equals total revenues minus total variable costs and total fixed costs. This profit equation is used extensively in cost-volume-profit (CVP) analysis, and the information in the profit equation is typically presented in the form of a contribution margin income statement (first introduced in Chapter 5 "How Do Organizations Identify Cost Behavior Patterns?"). What is the relationship between the profit equation and the contribution margin income statement?

**Answer:** Recall that the contribution margin income statement starts with sales, deducts variable costs to determine the contribution margin, and deducts fixed costs to arrive at profit. We use the term “variable cost” because it describes a cost that varies in total with changes in volume of activity. We use the term “fixed cost” because it describes a cost that is fixed (does not change) in total with changes in volume of activity.

To allow for a mathematical approach to performing CVP analysis, the contribution margin income statement is converted to an equation using the following variables:

**Key Equation**

\[
S = \text{Selling price per unit} \\
V = \text{Variable cost per unit} \\
F = \text{Total fixed costs} \\
Q = \text{Quantity of units produced and sold}
\]

Thus

\[
\text{Profit} = \text{Total sales} - \text{Total variable costs} - \text{Total fixed costs} = (S \times Q) - (V \times Q) - F
\]

Figure 6.1 "Comparison of Contribution Margin Income Statement with Profit Equation" clarifies the link between the contribution margin income statement presented in Chapter 5 "How Do Organizations Identify Cost Behavior Patterns?" and the profit equation stated previously. Study this figure carefully because you will encounter these concepts throughout the chapter.
Recall that when identifying cost behavior patterns, we assume that management is using the cost information to make short-term decisions. Variable and fixed cost concepts are useful for short-term decision making. The short-term period varies, depending on a company’s current production capacity and the time required to change capacity. In the long term, all cost behavior patterns are likely to change.

**Break-Even and Target Profit**

*Question: Companies such as Snowboard Company often want to know the sales required to break even, which is called the break-even point. What is meant by the term break-even point?*

*Answer: The break-even point can be described either in units or in sales dollars. The break-even point in units is the number of units that must be sold to achieve zero profit. The break-even point in sales dollars is the total sales measured in dollars required to achieve zero profit. If a company sells products or services easily measured in units (e.g., cars, computers, or mountain bikes), then the formula for break-even point in units is used. If a company sells products or services not easily measured in units (e.g., restaurants, law firms, or electricians), then the formula for break-even point in sales dollars is used.*

**Break-Even Point in Units**

*Question: How is the break-even point in units calculated, and what is the break-even point for Snowboard Company?*
Answer: The break-even point in units is found by setting profit to zero using the profit equation. Once profit is set to zero, fill in the appropriate information for selling price per unit (S), variable cost per unit (V), and total fixed costs (F), and solve for the quantity of units produced and sold (Q).

Let’s calculate the break-even point in units for Snowboard Company. Recall that each snowboard sells for $250. Unit variable costs total $150, and total monthly fixed costs are $50,000. To find the break-even point in units for Snowboard Company, set the profit to zero, insert the unit sales price (S), insert the unit variable cost (V), insert the total fixed costs (F), and solve for the quantity of units produced and sold (Q):

\[ 0 = (S \times Q) - (V \times Q) - F \]
\[ 0 = 250Q - 150Q - 50,000 \]
\[ 0 = 100Q - 50,000 \]
\[ 50,000 = 100Q \]
\[ Q = 500 \text{ units} \]

Thus Snowboard Company must produce and sell 500 snowboards to break even. This answer is confirmed in the following contribution margin income statement.

<table>
<thead>
<tr>
<th>Sales</th>
<th>Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$125,000</td>
<td>(500 units × $250)</td>
</tr>
<tr>
<td>75,000</td>
<td>(500 units × $150)</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>(given)</td>
</tr>
<tr>
<td>50,000</td>
<td>50,000</td>
</tr>
<tr>
<td>Fixed costs</td>
<td></td>
</tr>
<tr>
<td>50,000</td>
<td></td>
</tr>
<tr>
<td>Operating profit</td>
<td>$0</td>
</tr>
</tbody>
</table>

**Target Profit in Units**

*Question: Although it is helpful for companies to know the break-even point, most organizations are more interested in determining the sales required to make a targeted amount of profit. How does finding the target profit in units help companies like Snowboard Company?*

*Answer: Finding a target profit in units simply means that a company would like to know how many units of product must be sold to achieve a certain profit. At Snowboard Company, Recilia (the vice president of sales) and Lisa (the accountant) are in their next weekly meeting.*

Recilia, last week you asked how many units we have to sell to cover our expenses. This is called the break-even point. If each unit produced and sold provides $100 toward covering fixed costs, and if total monthly fixed costs are $50,000, we...
would have to sell 500 units to break even—that is, $50,000 divided by $100.

Recilia: What happens once we sell enough units to cover all of our fixed costs for the month?

Lisa: Good question! Once all fixed costs are covered for the month, each unit sold contributes $100 toward profit.

Recilia: I think I’m getting the hang of this. It will take 500 units in sales to break even, and each unit sold above 500 results in a $100 increase in profit. So if we sell 503 units for a month, profit will total $300?

Lisa: You’ve got it!

Recilia: So if our goal is to make a profit of $30,000 per month (target profit), how many units must be sold?

Lisa: It takes 500 units to break even. We also know each unit sold above and beyond 500 units contributes $100 toward profit. Thus we would have to sell an additional 300 units above the break-even point to earn a profit of $30,000. This means we would have to sell 800 units in total to make $30,000 in profit.

Recilia: Wow, I’m not sure selling 800 units is realistic, but at least we have a better sense of what needs to be done to make a decent profit. Thanks for your help!

### Profit Equation

**Question:** Let’s formalize this discussion by using the profit equation. How is the profit equation used to find a target profit amount in units?

**Answer:** Finding the target profit in units is similar to finding the break-even point in units except that profit is no longer set to zero. Instead, set the profit to the target profit the company would like to achieve. Then fill in the information for selling price per unit (S), variable cost per unit (V), and total fixed costs (F), and solve for the quantity of units produced and sold (Q):

\[
30,000 = (S \times Q) - (V \times Q) - F
\]

\[
30,000 = (250Q) - (150Q) - 50,000 = 100Q - 50,000
\]

\[
80,000 = 100Q
\]

\[
Q = 800 \text{ units}
\]

Thus Snowboard Company must produce and sell 800 snowboards to achieve $30,000 in profit. This answer is confirmed in the following contribution margin income statement:
Shortcut Formula

Question: Although using the profit equation to solve for the break-even point or target profit in units tends to be the easiest approach, we can also use a shortcut formula derived from this equation. What is the shortcut formula, and how is it used to find the target profit in units for Snowboard Company?

Answer: The shortcut formula is as follows:

Key Equation

\[ Q = \frac{(F + \text{Target Profit})}{(S - V)} \]

If you want to find the break-even point in units, set “Target Profit” in the equation to zero. If you want to find a target profit in units, set “Target Profit” in the equation to the appropriate amount. To confirm that this works, use the formula for Snowboard Company by finding the number of units produced and sold to achieve a target profit of $30,000:

\[ Q = \frac{(50,000 + 30,000)}{(250 - 150)} \]
\[ Q = \frac{80,000}{100} \]
\[ Q = 800 \text{ units} \]

The result is the same as when we used the profit equation.

Break-Even Point in Sales Dollars

Question: Finding the break-even point in units works well for companies that have products easily measured in units, such as snowboard or bike manufacturers, but not so well for companies that have a variety of products not easily measured in units, such as law firms and restaurants. How do companies find the break-even point if they cannot easily measure sales in units?

Answer: For these types of companies, the break-even point is measured in sales dollars. That is, we determine the total revenue (total sales dollars) required to achieve zero profit for companies that cannot easily measure sales in units.

Finding the break-even point in sales dollars requires the introduction of two new terms: contribution margin per unit and contribution margin ratio.
**Contribution Margin per Unit**

The contribution margin per unit is the amount each unit sold contributes to (1) covering fixed costs and (2) increasing profit. We calculate it by subtracting variable costs per unit (V) from the selling price per unit (S).

**Key Equation**

\[
\text{Contribution margin per unit} = S - V
\]

For Snowboard Company the contribution margin per unit is $100:

\[
S - V = $250 - $150 = $100
\]

Thus each unit sold contributes $100 to covering fixed costs and increasing profit.

**Contribution Margin Ratio**

The contribution margin ratio (often called contribution margin percent) is the contribution margin as a percentage of sales. It measures the amount each sales dollar contributes to (1) covering fixed costs and (2) increasing profit. The contribution margin ratio is the contribution margin per unit divided by the selling price per unit. (Note that the contribution margin ratio can also be calculated using the total contribution margin and total sales; the result is the same.)

**Key Equation**

\[
\text{Contribution margin ratio} = (S - V)/S
\]

For Snowboard Company the contribution margin ratio is 40 percent:

\[
(S - V)/S = ($250 - $150)/$250 = .40
\]

Thus each dollar in sales contributes 40 cents ($0.40) to covering fixed costs and increasing profit.

**Question:** With an understanding of the contribution margin and contribution margin ratio, we can now calculate the break-even point in sales dollars. How do we calculate the break-even point in sales dollars for Snowboard Company?
Answer: The formula to find the break-even point in sales dollars is as follows.

Key Equation

Break-even point in sales dollars = (Total fixed costs + Target profit)/(Contribution margin ratio)

For Snowboard Company the break-even point in sales dollars is $125,000 per month:

\[
\frac{($50,000 + $30,000)}{.40} = $200,000
\]

Thus Snowboard Company must achieve $125,000 in total sales to break even. The following contribution margin income statement confirms this answer:

<table>
<thead>
<tr>
<th>Sales</th>
<th>Amount</th>
<th>Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable costs</td>
<td>$75,000</td>
<td>(500 units x $150)</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$50,000</td>
<td>(500 units x $100)</td>
</tr>
<tr>
<td>Fixed costs</td>
<td>$50,000</td>
<td>(given)</td>
</tr>
<tr>
<td>Operating profit</td>
<td>$0</td>
<td></td>
</tr>
</tbody>
</table>

Target Profit in Sales Dollars

Key Equation

Target profit in sales dollars = (Total fixed costs + Target profit)/Contribution margin ratio

Question: Finding a target profit in sales dollars simply means that a company would like to know total sales measured in dollars required to achieve a certain profit. Finding the target profit in sales dollars is similar to finding the break-even point in sales dollars except that “target profit” is no longer set to zero. Instead, target profit is set to the profit the company would like to achieve. Recall that management of Snowboard Company asked the following question: What is the amount of total sales dollars required to earn a target profit of $30,000?
Answer: Use the break-even formula described in the previous section. Instead of setting the
target profit to $0, set it to $30,000. This results in an answer of $200,000 in monthly sales:

\[
\frac{\text{Total fixed costs} + \text{Target profit}}{\text{Contribution margin ratio}} = \frac{($50,000 + $30,000)}{0.40} = $200,000
\]

Thus Snowboard Company must achieve $200,000 in sales to make $30,000 in monthly profit.
The following contribution margin income statement confirms this answer:

![Contribution Margin Income Statement](image)

**Business in Action 6.1**

Measuring the Break-Even Point for Airlines

During the month of September 2001, United Airlines was losing $15 million per day. With $2.7 billion in
cash, United had six months to return to profitability before facing a significant cash shortage. Many analysts
believed United’s troubles resulted in part from a relatively high break-even point.

Airlines measure break-even points, also called **load factors**, in terms of the percentage of seats filled. At the end of 2001, one firm estimated that United had to fill 96 percent of its seats just to break even. This is well above the figure for other major airlines, as you can see in the list that follows:

- **American Airlines**: 85 percent
- **Delta Airlines**: 85 percent
- **Southwest Airlines**: 65 percent
- **Alaska Airlines**: 75 percent

United Airlines filed for bankruptcy at the end of 2002 and emerged from bankruptcy in 2006 after reducing costs by $7 billion a year. Other airlines continue to work on reducing their break-even points and maximizing the percentage of seats filled.

CVP Graph

Question: The relationship of costs, volume, and profit can be displayed in the form of a graph. What does this graph look like for Snowboard Company, and how does it help management evaluate financial information related to the production of snowboards?

Answer: Figure 6.2 "CVP Graph for Snowboard Company" shows in graph form the relationship between cost, volume, and profit for Snowboard Company. The vertical axis represents dollar amounts for revenues, costs, and profits. The horizontal axis represents the volume of activity for a period, measured as units produced and sold for Snowboard.

There are three lines in the graph:

- Total revenue
- Total cost
- Profit

The total revenue line shows total revenue based on the number of units produced and sold. For example, if Snowboard produces and sells one unit, total revenue is $250 (\(= 1 \times 250\)). If it produces and sells 2,000 units, total revenue is $500,000 (\(= 2,000 \times 250\)).

The total cost line shows total cost based on the number of units produced and sold. For example, if Snowboard produces and sells one unit, total cost is $50,150 \(= 50,000 + (1 \times 150)\)). If it produces and sells 2,000 units, total cost is $350,000 \(= 50,000 + (2,000 \times 150)\)).

The profit line shows profit or loss based on the number of units produced and sold. It is simply the difference between the total revenue and total cost lines. For example, if Snowboard produces and sells 2,000 units, the profit is $150,000 \(= 500,000 - 350,000\). If no units are sold, a loss is incurred equal to total fixed costs of $50,000.
Question: Managers often like to know how close projected sales are to the break-even point. How is this information calculated and used by management?

Answer: The excess of projected sales over the break-even point is called the margin of safety. The margin of safety represents the amount by which sales can fall before the company incurs a loss.

Key Equation

Margin of safety (in units) = Projected sales (in units) - Break-even sales (in units)

Assume Snowboard Company expects to sell 700 snowboards and that its break-even point is 500 units; the margin of safety is 200 units. The calculation is

Margin of safety (in units) = Projected sales (in units) - Break-even sales (in units) = 700 – 500 = 200

Thus sales can drop by 200 units per month before the company begins to incur a loss.

The margin of safety can also be stated in sales dollars.

Key Equation

Margin of safety (in sales $) = Projected sales (in sales $) – Break-even sales (in sales $)
Cost-volume-profit analysis involves finding the break-even and target profit point in units and in sales dollars. The key formulas for an organization with a single product are summarized in the following list. Set the target profit to $0 for break-even calculations, or to the appropriate profit dollar amount for target profit calculations. The margin of safety formula is also shown:

1. Break-even or target profit point measured in units:

   \[
   \frac{(\text{Total fixed costs} + \text{Target profit})}{(\text{Selling price per unit} - \text{Variable cost per unit})}
   \]

   (The denominator is also called “contribution margin per unit.”)

2. Break-even or target profit point measured in sales dollars:

   \[
   \frac{(\text{Total fixed costs} + \text{Target profit})}{\text{Contribution margin ratio}}
   \]

3. Margin of safety in units or sales dollars:

   \[
   \text{Projected sales} - \text{Break-even sales}
   \]

**Review Problem 6.1**

Star Symphony would like to perform for a neighboring city. Fixed costs for the performance total $5,000. Tickets will sell for $15 per person, and an outside organization responsible for processing ticket orders charges the symphony a fee of $2 per ticket. Star Symphony expects to sell 500 tickets.

1. How many tickets must Star Symphony sell to break even?
2. How many tickets must the symphony sell to earn a profit of $7,000?
3. How much must Star Symphony have in sales dollars to break even?
4. How much must Star Symphony have in sales dollars to earn a profit of $7,000?
5. What is the symphony’s margin of safety in units and in sales dollars?

**Solution to Review Problem 6.1**

Note: All solutions are rounded.
1. The symphony must sell 385 tickets to break even:

\[
\text{(Total fixed costs + Target profit)/(Selling price per unit - Variable cost per unit)} = \frac{($5,000 + $0)}{($15 - $2)} = 385 \text{ tickets (rounded)}
\]

2. The symphony must sell 923 tickets to make a profit of $7,000:

\[
\text{(Total fixed costs + Target profit)/(Selling price per unit - Variable cost per unit)} = \frac{($5,000 + $7,000)}{($15 - $2)} = 923 \text{ tickets (rounded)}
\]

3. The symphony must make $5,769 in sales to break even:

\[
\text{(Total fixed costs + Target profit)/Contribution margin ratio} = \frac{($5,000 + $0)}{($15 - $2)/$15} = $5,769 \text{ (rounded)}
\]

4. The symphony must make $13,846 in sales to earn a profit of $7,000:

\[
\text{(Total fixed costs + Target profit)/Contribution margin ratio} = \frac{($5,000 + $7,000)}{($15 - $2)/$15} = $13,846 \text{ (rounded)}
\]

5. The symphony’s margin of safety is 115 units or $1,725 in sales:

\[
\text{Margin of safety (in units)} = \text{Projected sales (in units)} - \text{Break-even sales (in units)} = 500 \text{ tickets} - 385 \text{ tickets} = 115 \text{ tickets}
\]

\[
\text{Margin of safety (in sales $)} = \text{Projected sales (in sales $)} - \text{Break-even sales (in sales $)} = (500 \times $15) - (385 \times $15) = $1,725
\]

### 6.2 Cost-Volume-Profit Analysis for Multiple-Product and Service Companies

**Learning Objective**

1. Perform cost-volume-profit analysis for multiple-product and service companies.

**Question:** Although the previous section illustrated cost-volume-profit (CVP) analysis for companies with a single product easily measured in units, most companies have more than one product or perhaps offer services not easily measured in units. Suppose you are the manager of a company called Kayaks-For-Fun that produces two kayak models, River and Sea. What information is needed to calculate the break-even point for this company?

**Answer:** The following information is required to find the break-even point:

- Monthly fixed costs total $24,000.
- The River model represents 60 percent of total sales volume and the Sea model accounts for 40 percent of total sales volume.
- The unit selling price and variable cost information for the two products follow:
Finding the Break-Even Point and Target Profit in Units for Multiple-Product Companies

Question: Given the information provided for Kayaks-For-Fun, how will the company calculate the break-even point?

Answer: First, we must expand the profit equation presented earlier to include multiple products. The following terms are used once again. However, subscript \( r \) identifies the River model, and subscript \( s \) identifies the Sea model (e.g., \( S_r \) stands for the River model’s selling price per unit). CM is new to this section and represents the contribution margin.

Key Equation

Profit = Total sales − Total variable costs − Total fixed costs

Without going through a detailed derivation, this equation can be restated in a simplified manner for Kayaks-For-Fun, as follows:

\[
\text{Profit} = (\text{Unit CM for River} \times \text{Quantity of River}) + (\text{Unit CM for Sea} \times \text{Quantity of Sea}) – F = 400Q_r + 150Q_s – 24,000
\]

One manager at Kayaks-For-Fun believes the break-even point should be 60 units in total, and another manager believes the break-even point should be 160 units in total. Which manager is correct? The answer is both might be correct. If only the River kayak is produced and sold, 60 units is the break-even point. If only the Sea kayak is produced and sold, 160 units is the break-even point. There actually are many different break-even points, because the profit equation has two unknown variables, \( Q_r \) and \( Q_s \).
Further evidence of multiple break-even points is provided as follows (allow for rounding to the nearest unit), and shown graphically in Figure 6.3:

Profit = (Unit CM for Product 1 x Quantity of Product 1) + (Unit CM for Product 2 x Quantity of Product 2) - Fixed costs

Figure 6.3 Multiple Break-Even Points for Kayaks-For-Fun

Break-Even Point in Units and the Weighted Average Contribution Margin per Unit

Question: Because most companies sell multiple products that have different selling prices and different variable costs, the break-even or target profit point depends on the sales mix. What is the sales mix, and how is it used to calculate the break-even point?

Answer: The sales mix is the proportion of one product’s sales to total sales. In the case of Kayaks-For-Fun, the River model accounts for 60 percent of total unit sales and the Sea model accounts for 40 percent of total unit sales.

In calculating the break-even point for Kayaks-For-Fun, we must assume the sales mix for the River and Sea models will remain at 60 percent and 40 percent, respectively, at all different sales levels. The formula used to solve for the break-even point in units for multiple-product companies is similar to the one used for a single-product company, with one change. Instead of using the contribution margin per unit in the denominator, multiple-product companies use
a weighted average contribution margin per unit. The formula to find the break-even point in units is as follows.

**Key Equation**

\[
\frac{(\text{Total fixed costs} + \text{Target profit})}{\text{Weighted average contribution margin per unit}}
\]

When a company assumes a constant sales mix, a weighted average contribution margin per unit can be calculated by multiplying each product’s unit contribution margin by its proportion of total sales. The resulting weighted unit contribution margins for all products are then added together.

At Kayaks-For-Fun, the weighted average contribution margin per unit of $300 is

\[
$300 = ($400 \times 60\% ) + ($150 \times 40\% )
\]

We can now determine the break-even point in units by using the following formula:

\[
\text{Break-even point in units} = \frac{(\text{Total fixed costs} + \text{Target profit})}{\text{Weighted average contribution margin per unit}}
\]

\[
\text{Break-even point in units} = \frac{($24,000 + $0)}{$300} = 80 \text{ total kayaks}
\]

Kayaks-For-Fun must sell 48 River models (= 60 percent \times 80 units) and 32 Sea models (= 40 percent \times 80 units) to break even. Again, this assumes the sales mix remains the same at different levels of sales volume.

**Target Profit in Units**

*Question:* We now know how to calculate the break-even point in units for a company with multiple products. How do we extend this process to find the target profit in units for a company with multiple products?

*Answer:* Finding the target profit in units for a company with multiple products is similar to finding the break-even point in units except that profit is no longer set to zero. Instead, profit is set to the target profit the company would like to achieve.
Key Equation

Target profit in units = (Total fixed costs + Target profit)/Weighted average contribution margin per unit

For example, assume Kayaks-For-Fun would like to know how many units it must sell to make a monthly profit of $96,000. Simply set the target profit to $96,000 and run the calculation:

Target profit in units = ($24,000+$96,000)/$300 = 400 total kayaks

Kayaks-For-Fun must sell 240 River models (= 60 percent × 400) and 160 Sea models (= 40 percent × 400) to make a profit of $96,000.

International Printer Machines (IPM) builds three computer printer models: Inkjet, Laser, and Color Laser. Information for these three products is as follows:

<table>
<thead>
<tr>
<th></th>
<th>Inkjet</th>
<th>Laser</th>
<th>Color Laser</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selling price per unit</td>
<td>$250</td>
<td>$400</td>
<td>$1,600</td>
<td></td>
</tr>
<tr>
<td>Variable cost per unit</td>
<td>$100</td>
<td>$150</td>
<td>$800</td>
<td></td>
</tr>
<tr>
<td>Expected unit sales (annual)</td>
<td>12,000</td>
<td>6,000</td>
<td>2,000</td>
<td>20,000</td>
</tr>
<tr>
<td>Sales mix</td>
<td>60 percent</td>
<td>30 percent</td>
<td>10 percent</td>
<td>100 percent</td>
</tr>
</tbody>
</table>

Total annual fixed costs are $5,000,000. Assume the sales mix remains the same at all levels of sales.

1. How many printers in total must be sold to break even?
2. How many units of each printer must be sold to break even?

1. How many printers in total must be sold to earn an annual profit of $1,000,000?
2. How many units of each printer must be sold to earn an annual profit of $1,000,000?

Solution to Review Problem 6.2

Note: All solutions are rounded.

1. IPM must sell 20,408 printers to break even:
Total fixed costs + Target profit)/Weighted average contribution margin per unit

\[(\$5,000,000 + 0)/(($150 \times 0.60) + ($250 \times 0.30) + ($800 \times 0.10)) = \$5,000,000/\$245 = 20,408 \text{ total units}\]

2. As calculated previously, 20,408 printers must be sold to break even. Using the sales mix provided, the following number of units of each printer must be sold to break even:

- Inkjet: 12,245 units = 20,408 \times 0.60
- Laser: 6,122 units = 20,408 \times 0.30
- Color laser: 2,041 units = 20,408 \times 0.10

IPM must sell 24,490 printers to earn $1,000,000 in profit:

\[(\text{Total fixed costs} + \text{Target profit})/\text{Weighted average contribution margin per unit}\]

\[(\$5,000,000 + 0)/(($150 \times 0.60) + ($250 \times 0.30) + ($800 \times 0.10)) = \$6,000,000/\$245 = 24,490 \text{ total units}\]

As calculated previously, 24,490 printers must be sold to earn $1,000,000 in profit. Using the sales mix provided, the following number of units for each printer must be sold to earn $1,000,000 in profit:

- Inkjet: 14,694 units = 24,490 \times 0.60
- Laser: 7,347 units = 24,490 \times 0.30
- Color laser: 2,449 units = 24,490 \times 0.10

Finding the Break-Even Point and Target Profit in Sales Dollars for Multiple-Product and Service Companies

A restaurant like Applebee’s, which serves chicken, steak, seafood, appetizers, and beverages, would find it difficult to measure a “unit” of product. Such companies need a different approach to finding the break-even point. For example, some companies have similar products easily measured in units (kayaks) while other companies have unique products (meals at a restaurant) not easily measured in units.

Break-Even Point in Sales Dollars and the Weighted Average Contribution Margin Ratio

Question: For companies that have unique products not easily measured in units, how do we find the break-even point?
Answer: Rather than measuring the break-even point in units, a more practical approach for these types of companies is to find the break-even point in sales dollars. We can use the formula that follows to find the break-even point in sales dollars for organizations with multiple products or services. Note that this formula is similar to the one used to find the break-even point in sales dollars for an organization with one product, except that the contribution margin ratio now becomes the weighted average contribution margin ratio.

Key Equation

\[
\text{Break-even point in sales dollars} = \frac{\text{Total fixed costs} + \text{Target profit}}{\text{Weighted average contribution margin ratio}}
\]

For example, suppose Amy’s Accounting Service has three departments—tax, audit, and consulting—that provide services to the company’s clients. Figure 6.5 "Income Statement for Amy’s Accounting Service" shows the company’s income statement for the year. Amy, the owner, would like to know what sales are required to break even. Note that fixed costs are known in total, but Amy does not allocate fixed costs to each department.

**Figure 6.5 Income Statement for Amy’s Accounting Service**

<table>
<thead>
<tr>
<th></th>
<th>Tax</th>
<th>Audit</th>
<th>Consulting</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>$100,000</td>
<td>$150,000</td>
<td>$250,000</td>
<td>$500,000</td>
</tr>
<tr>
<td>Variable costs</td>
<td>$30,000</td>
<td>$120,000</td>
<td>$125,000</td>
<td>$275,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$70,000</td>
<td>$30,000</td>
<td>$125,000</td>
<td>$225,000</td>
</tr>
<tr>
<td>Fixed costs</td>
<td></td>
<td></td>
<td></td>
<td>$120,000</td>
</tr>
<tr>
<td>Operating profit</td>
<td></td>
<td></td>
<td></td>
<td>$105,000</td>
</tr>
</tbody>
</table>

The contribution margin ratio differs for each department:

<table>
<thead>
<tr>
<th>Department</th>
<th>Contribution Margin Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tax</td>
<td>70 percent (= $70,000 / $100,000)</td>
</tr>
<tr>
<td>Audit</td>
<td>20 percent (= $30,000 / $150,000)</td>
</tr>
<tr>
<td>Consulting</td>
<td>50 percent (= $125,000 / $250,000)</td>
</tr>
</tbody>
</table>
Question: We have the contribution margin ratio for each department, but we need it for the company as a whole. How do we find the contribution margin ratio for all of the departments in the company combined?

Answer: The contribution margin ratio for the company as a whole is the weighted average contribution margin ratio. We calculate it by dividing the total contribution margin by total sales. For Amy’s Accounting Service, the weighted average contribution margin ratio is 45 percent (=$225,000 ÷ $500,000). For every dollar increase in sales, the company will generate an additional 45 cents ($0.45) in profit. This assumes that the sales mix remains the same at all levels of sales. (The sales mix here is measured in sales dollars for each department as a proportion of total sales dollars.)

Now that you know the weighted average contribution margin ratio for Amy’s Accounting Service, it is possible to calculate the break-even point in sales dollars:

\[ \text{Break-even point in sales dollars} = 120,000 + \frac{0}{0.45} = $266,667 \text{ (rounded)} \]

Amy’s Accounting Service must achieve $266,667 in sales to break even.[1]

Target Profit in Sales Dollars

Question: How do we find the target profit in sales dollars for companies with products not easily measured in units?

Answer: Finding the target profit in sales dollars for a company with multiple products or services is similar to finding the break-even point in sales dollars except that profit is no longer set to zero. Instead, profit is set to the target profit the company would like to achieve.

Key Equation

\[
\text{Target profit in sales dollars} = \frac{\text{Total fixed costs} + \text{Target profit}}{\text{Weighted average contribution margin ratio}}
\]

For example, assume Amy’s Accounting Service would like to know sales dollars required to make $250,000 in annual profit. Simply set the target profit to $250,000 and run the calculation:

\[
\text{Target profit in sales dollars} = \frac{120,000 + 250,000}{0.45} = $822,222 \text{ (rounded)}
\]
Amy’s Accounting Service must achieve $822,222 in sales to earn $250,000 in profit.

Important Assumptions

*Question:* Several assumptions are required to perform break-even and target profit calculations for companies with multiple products or services. What are these important assumptions?

*Answer:* These assumptions are as follows:

- Costs can be separated into fixed and variable components.
- Contribution margin ratio remains constant for each product, segment, or department.
- Sales mix remains constant with changes in total sales.

These assumptions simplify the CVP model and enable accountants to perform CVP analysis quickly and easily. However, these assumptions may not be realistic, particularly if significant changes are made to the organization’s operations. When performing CVP analysis, it is important to consider the accuracy of these simplifying assumptions. It is always possible to design a more accurate and complex CVP model. But the benefits of obtaining more accurate data from a complex CVP model must outweigh the costs of developing such a model.

Margin of Safety

*Question:* Managers often like to know how close expected sales are to the break-even point. As defined earlier, the excess of projected sales over the break-even point is called the margin of safety. How is the margin of safety calculated for multiple-product and service organizations?

*Answer:* Let’s return to Amy’s Accounting Service and assume that Amy expects annual sales of $822,222, which results in expected profit of $250,000. Given a break-even point of $266,667, the margin of safety in sales dollars is calculated as follows:

\[
\text{Margin of safety} = \text{Projected sales} - \text{Break-even sales} = \$822,222 - \$266,667 = \$555,555
\]

Thus sales revenue can drop by $555,555 per year before the company begins to incur a loss.

**KEY TAKEAWAYS**
The key formula used to calculate the break-even or target profit point in units for a company with multiple products is as follows.

\[
\text{Total fixed costs} + \text{Target profit} = \frac{\text{Weighted average contribution margin per unit}}{\text{Target profit}}
\]

The formula used to find the break-even point or target profit in sales dollars for companies with multiple products or service is as follows. Simply set the “Target Profit” to $0 for break-even calculations, or to the appropriate profit dollar amount for target profit calculations:

\[
\text{Total fixed costs} + \text{Target profit} = \frac{\text{Weighted Average contribution margin ratio}}{\text{Target profit}}
\]

### REVIEW PROBLEM 6.3

Ott Landscape Incorporated provides landscape maintenance services for three types of clients: commercial, residential, and sports fields. Financial projections for this coming year for the three segments are as follows:

<table>
<thead>
<tr>
<th>Sales</th>
<th>Commercial</th>
<th>Residential</th>
<th>Sports Fields</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable costs</td>
<td>$2,100,000</td>
<td>$1,000,000</td>
<td>$1,900,000</td>
<td>$5,000,000</td>
</tr>
<tr>
<td>Fixed costs</td>
<td>1,800,000</td>
<td>800,000</td>
<td>1,400,000</td>
<td>4,000,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$300,000</td>
<td>$200,000</td>
<td>$500,000</td>
<td>$1,000,000</td>
</tr>
<tr>
<td>Operating profit</td>
<td>$1,500,000</td>
<td>$1,200,000</td>
<td>$1,400,000</td>
<td>$2,500,000</td>
</tr>
</tbody>
</table>

Assume the sales mix remains the same at all levels of sales.

1. How much must Ott Landscape have in total sales dollars to break even?
2. How much must Ott Landscape have in total sales dollars to earn an annual profit of $1,500,000?
3. What is the margin of safety, assuming projected sales are $5,000,000 as shown previously?

### Solution to Review Problem 6.3

1. Sales of $1,000,000 are required to break even:

   \[
   \text{Total fixed costs} + \text{Target profit} = \frac{\text{Weighted average contribution margin ratio}*}{\text{Target profit}} = \frac{\$200,000 + \$0}{0.20} = \$1,000,000 \text{ in sales}
   \]

   \*Weighted average contribution margin ratio = \$1,000,000 ÷ \$5,000,000 = 20 percent or 0.20.

2. Sales of $8,500,000 are required to make a profit of $1,500,000:

   \[
   \text{Total fixed costs} + \text{Target profit} = \frac{\text{Weighted average contribution margin ratio}}{\text{Target profit}} = \frac{\$200,000 + \$1,500,000}{0.20} = \$8,500,000 \text{ in sales}
   \]

3. The margin of safety is $4,000,000 in sales.
[1] The weighted average contribution margin ratio can also be found by multiplying each department’s contribution margin ratio by its proportion of total sales. The resulting weighted average contribution margin ratios for all departments are then added. The calculation for Amy’s Accounting Service is as follows: 45 percent weighted average contribution margin ratio = (tax has 20 percent of total sales × 70 percent contribution margin ratio) + (audit has 30 percent of total sales × 20 percent contribution margin ratio) + (consulting has 50 percent of total sales × 50 percent contribution margin ratio) Thus 45 percent = 14 percent + 6 percent + 25 percent.

### 6.3 Using Cost-Volume-Profit Models for Sensitivity Analysis

#### LEARNING OBJECTIVE

1. Use sensitivity analysis to determine how changes in the cost-volume-profit equation affect profit.

**Question:** We can use the cost-volume-profit (CVP) financial model described in this chapter for single-product, multiple-product, and service organizations to perform sensitivity analysis, also called what-if analysis. How is sensitivity analysis used to help managers make decisions?

**Answer:** Sensitivity analysis shows how the CVP model will change with changes in any of its variables (e.g., changes in fixed costs, variable costs, sales price, or sales mix). The focus is typically on how changes in variables will alter profit.

**Sensitivity Analysis: An Example**

To illustrate sensitivity analysis, let’s go back to Snowboard Company, a company that produces one snowboard model. The assumptions for Snowboard were as follows:

<table>
<thead>
<tr>
<th>Sales price per unit</th>
<th>$250</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable cost per unit</td>
<td>150</td>
</tr>
<tr>
<td>Fixed costs per month</td>
<td>50,000</td>
</tr>
<tr>
<td>Target profit</td>
<td>30,000</td>
</tr>
</tbody>
</table>
Chapter 7

How Are Relevant Revenues and Costs Used to Make Decisions?

Bob Lee is president of Best Boards, Inc., a manufacturer of wakeboards. In the face of stiff competition, Best Boards’ profits have declined steadily over the past few years. Bob is concerned about the decline in profits and has instructed Jim Muller, the vice president of operations, to do whatever it takes to reduce costs. In fact, Bob offered to pay Jim a bonus equal to 25 percent of any production cost savings the company achieves during the coming year.

Jim Muller thinks he has a way to cut costs and earn his bonus, and he approaches Bob Lee and Amy Eckstrom, the company’s accountant, to discuss his plan:

<table>
<thead>
<tr>
<th>Jim:</th>
<th>Bob and Amy, I hope you’ve had a chance to review my proposal to outsource production. I think it could save the company thousands of dollars this coming year.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bob:</td>
<td>I did review your proposal. Give me a quick summary of what you have in mind.</td>
</tr>
<tr>
<td>Jim:</td>
<td>Our staff accountants tell me that the average unit product cost for our wakeboards is about $110, and we make 10,000 wakeboards each year.</td>
</tr>
<tr>
<td>Amy:</td>
<td>Sounds about right.</td>
</tr>
<tr>
<td>Jim:</td>
<td>My thought is that we could save substantial amounts of money by having an outside supplier make our wakeboards rather than doing it ourselves. I contacted one reputable wakeboard manufacturer interested in producing the boards for us.</td>
</tr>
<tr>
<td>Bob:</td>
<td>What did you find?</td>
</tr>
<tr>
<td>Jim:</td>
<td>They told me the wakeboards could be purchased from them for $70 a board. This amounts to $40 in savings per unit, and $400,000 in total savings! Even after my 25 percent bonus of $100,000, Best Boards would save $300,000.</td>
</tr>
<tr>
<td>Jim:</td>
<td>Jim has an interesting idea, but there are some issues that should be considered. Jim, you are correct in stating the average unit product cost for our wakeboards is $110 given production of 10,000 units per year. However, it is not accurate to assume we will eliminate $1,100,000, which is $110 per unit cost times 10,000 units, in total production costs by outsourcing production. The average unit cost includes factory equipment lease payments, along with supervisors’ salaries, and factory rent. These costs don’t go away quickly if we stop production. The equipment lease is for several years, we are locked into a long-term lease for the factory building, and we would have to look at our supervisors’ contracts before letting them go.</td>
</tr>
<tr>
<td>Amy:</td>
<td>Can we get a better idea of which costs would be eliminated by outsourcing production, and which costs would remain?</td>
</tr>
<tr>
<td>Amy:</td>
<td>Sure. I’ll get a team working on this right away.</td>
</tr>
</tbody>
</table>

Best Boards is facing a decision common to many organizations: whether to build its own product or to have another company build the product. We will come back to this scenario after
describing how companies facing such decisions can use differential analysis to make wise business decisions.

7.1 Using Differential Analysis to Make Decisions

LEARNING OBJECTIVE

1. Describe the format used for differential analysis.

Differential revenues and costs (also called relevant revenues and costs or incremental revenues and costs) represent the difference in revenues and costs among alternative courses of action. Analyzing this difference is called differential analysis (or incremental analysis). We begin with a relatively simple example to establish the format used to perform differential analysis and present more complicated examples later in the chapter. As you work through this example, notice that we also use the contribution margin income statement format presented in Chapter 5 "How Do Organizations Identify Cost Behavior Patterns?" and Chapter 6 "How Is Cost-Volume-Profit Analysis Used for Decision Making?".

Question: Assume Phillips Accountancy provides bookkeeping, tax, and audit services to its clients. Management believes Phillips Accountancy has several unprofitable customers and would like to perform differential analysis to find out how profits would change if Phillips dropped these customers. Alternative 1 includes the annual revenues, costs, and resulting profit if the company keeps all existing customers. Alternative 2 includes the annual revenues, costs, and resulting profit if the company drops what it believes are unprofitable customers. How should management decide whether to keep all existing customers or drop certain customers?

Answer: Figure 7.1 "Differential Analysis for Phillips Accountancy" presents the format used by management to perform differential analysis. In this case, differential analysis is used to evaluate whether Phillips Accounting should keep all customers or drop unprofitable customers. The information in Figure 7.1 confirms that Phillips Accountancy would be better off dropping the unprofitable customers (Alternative 2), because company profits would increase by $20,000. The general rule is to select the alternative with the highest differential profit. Take a close look at Figure 7.1 "Differential Analysis for Phillips Accountancy" before reading the description of this information that follows.
Notice that in Figure 7.1 the columns labeled Alternative 1 and Alternative 2 show revenues, costs, and profit for each alternative. The third column, labeled Differential Amount, presents the differential revenues and costs and resulting differential profit. Positive amounts appearing in this column indicate Alternative 1 is higher than Alternative 2. Negative amounts appearing in the Differential Amount column indicate Alternative 1 is lower than Alternative 2. The fourth column shows whether Alternative 1 is higher or lower than Alternative 2 for each line item.

For example, the differential amount of $1,000,000 for revenue indicates Alternative 1 produces $1,000,000 more in revenue than Alternative 2. The differential amount of $750,000 for variable costs indicates variable costs are $750,000 higher for Alternative 1 than for Alternative 2. Move to the bottom of Figure 7.1. Notice that the differential amount for profit is negative ($20,000). This indicates that Alternative 1 results in profits that are $20,000 lower than Alternative 2. Thus Alternative 2 (dropping unprofitable customers) is the desirable course of action.

Notice that the columns labeled Alternative 1 and Alternative 2 show information in summary form (i.e., no detail is provided for revenues, variable costs, or fixed costs). Some managers may want only this type of summary information, whereas others may prefer more detailed information. It is important to be flexible with the format, to best meet the needs of managers.

We will build upon the differential analysis format shown in Figure 7.1 throughout this chapter, and show how more detail can easily be provided using the same format.

Next, this chapter focuses on how we use differential analysis to assist in making the following types of decisions:
• Make or buy products
• Keep or drop product lines
• Keep or drop customers
• Accept or reject special customer orders

**KEY TAKEAWAY**

- Differential revenues and costs represent the difference in revenues and costs among alternative courses of action. Analyzing this difference is called differential analysis. Differential analysis is useful in making managerial decisions related to making or buying products, keeping or dropping product lines, keeping or dropping customers, and accepting or rejecting special customer orders.

**REVIEW PROBLEM 7.1**

Coffee Express is a small coffee shop looking to expand its product offerings beyond coffee. The company is evaluating two alternatives—sandwiches and cookies. Annual projections for sales of sandwiches are as follows: sales, $18,000; variable costs, $13,000; and fixed costs, $500. Annual projections for sales of cookies are as follows: sales, $10,000; variable costs, $3,000; and no additional fixed costs.

Using the format in Figure 7.1, perform differential analysis to determine which alternative is more profitable, and by how much.

Assume adding sandwiches is Alternative 1 and adding cookies is Alternative 2.

Solution to Review Problem 7.1

As shown in the differential analysis given, selling cookies is the most profitable alternative. Selling cookies results in profits of $7,000 for the year, which is $2,500 higher than the sandwich alternative.
7.3 Product Line Decisions

**LEARNING OBJECTIVE**

1. Use differential analysis for product line decisions.

**Question:** As competitors enter the market and as products go through life cycles, managers often must decide whether to keep or drop product lines. A product line is a group of related products. The Home Depot, Inc., has many different product lines such as appliances, flooring, and paint products. Ford Motor Co. produces a variety of products such as compact cars, trucks, and tractors. Companies must continually assess whether they should add new product lines, and whether they should discontinue current product lines. Differential analysis provides a format for these types of decisions. How would differential analysis be used to make a product line decision?

**Answer:** Let’s look at an example of a product line decision. Assume Barbeque Company has three product lines: gas barbecues, charcoal barbecues, and barbecue accessories. Charcoal barbecue sales have declined in recent years, leading management to question whether this product line is worth keeping. Barbeque Company would like to consider two alternatives. Alternative 1 is to retain all three product lines, and Alternative 2 is to eliminate the charcoal barbecues product line. Figure 7.4 "Product Line Decision" shows the decision facing the manager at Barbeque Company: whether to eliminate or keep the charcoal barbecue product line.

*Figure 7.4 Product Line Decision*
Figure 7.5 "Income Statement for Barbeque Company" presents the income statement for the past year, separated by product line (this is often referred to as a segmented income statement). Carefully examine Figure 7.5 "Income Statement for Barbeque Company". Notice that the
charcoal barbecues product line shows a loss of $8,000 for the year. This is the reason management would like to consider dropping this product line.

*Figure 7.5 Income Statement for Barbeque Company*

*Includes cost of goods sold and other variable costs.*

The variable costs in Figure 7.5 "Income Statement for Barbeque Company" are related directly to each product line, and thus are eliminated if the product line is eliminated. That is, all variable costs are differential costs for the two alternatives facing Barbeque Company.

*Question: Notice that two lines appear for fixed costs: direct fixed costs and allocated fixed costs. What is the difference between direct fixed costs and allocated fixed costs?*

*Answer: Direct fixed costs are fixed costs that can be traced directly to a product line. Direct fixed costs are often differential costs. For example, the salary of the manager responsible for charcoal barbecues is easily traced to the charcoal barbecues product line. If this product line is eliminated, the product line manager’s salary is also eliminated (unless the product line manager has a long-term employment contract).

Allocated fixed costs (also called common fixed costs) are fixed costs that cannot be traced directly to a product line, and therefore are assigned to product lines using an allocation process. Allocated fixed costs are typically not differential costs. For example, rent paid for Barbeque
Company’s retail store is allocated to all three product lines because it is not easily traced to each product line. However, the retail store rent likely will not decrease if the charcoal barbecues product line is eliminated (unless the company chooses to move to a smaller, less costly store). The charcoal barbecues’ allocation for rent would simply be reallocated to the other two products. Thus rent for the retail store is an example of an allocated fixed cost that is not a differential cost for the two alternatives facing Barbeque Company.

**Question:** How are Barbeque Company’s allocated fixed costs assigned to individual product lines?

Answer: Barbeque Company’s total allocated fixed costs of $120,000 are allocated based on sales. Sales revenue for gas barbecues totals $450,000, which is 75 percent of total company sales ($450,000 ÷ $600,000). Thus 75 percent of all allocated fixed costs are assigned to the gas barbecues product line. This amounts to $90,000 ($120,000 × 0.75).

**Question:** Will dropping the charcoal barbecues product line result in higher company profit?

Answer: The differential analysis presented in Figure 7.6 "Product Line Differential Analysis for Barbeque Company" provides the answer. Panel A shows the income statement for Alternative 1: keeping all three product lines. Panel B shows the income statement for Alternative 2: dropping the charcoal barbecues product line. And panel C presents the differential analysis for the two alternatives. The differential analysis in panel C shows that overall profit will decrease by $10,000 if the charcoal barbecue product line is dropped.
Figure 7.6 Product Line Differential Analysis for Barbeque Company

| Panel A: Alternative 1 (keep all product lines) |
|---------------------|---------------------|---------------------|---------------------|
|                    | Gas Barbecues       | Charcoal Barbecues  | Barbecue Accessories|
| Sales revenue      | $450,000            | $90,000             | $60,000             |
| Variable costs     | 110,000             | -40,000             | 15,000              |
| Contribution margin| $340,000            | $50,000             | $45,000             |
| Direct fixed costs | 60,000              | 40,000              | 16,000              |
| Allocated fixed costs | 90,000           | 16,000              | 12,000              |
| Profit (loss)      | $190,000            | $(8,000)            | $17,000             |
| Total              | $600,000            | $165,000            | $435,000            |

| Panel B: Alternative 2 (drop the charcoal barbecues line) |
|---------------------|---------------------|---------------------|
|                    | Gas Barbecues       | Barbecue Accessories|
| Sales revenue      | $450,000            | $60,000             |
| Variable costs     | 110,000             | 15,000              |
| Contribution margin| $340,000            | $45,000             |
| Direct fixed costs | 60,000              | 16,000              |
| Allocated fixed costs | 105,882^2          | 14,118^-              |
| Profit             | $174,118            | $14,882             |
| Total              | $510,000            | $125,000            |

<table>
<thead>
<tr>
<th>Panel C: Differential Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative 1 Total (keep all product lines; panel A)</td>
</tr>
<tr>
<td>Sales revenue</td>
</tr>
<tr>
<td>Variable costs</td>
</tr>
<tr>
<td>Contribution margin</td>
</tr>
<tr>
<td>Direct fixed costs</td>
</tr>
<tr>
<td>Allocated fixed costs</td>
</tr>
<tr>
<td>Profit</td>
</tr>
</tbody>
</table>

| Alternative 2 Total (drop charcoal barbecues; panel B) |
| Sales revenue | $510,000 |
| Variable costs | $125,000 |
| Contribution margin | $385,000 |
| Direct fixed costs | $76,000 |
| Allocated fixed costs | $120,000 |
| Profit | $189,000 |

<table>
<thead>
<tr>
<th>Differential Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>$90,000</td>
</tr>
<tr>
<td>$40,000</td>
</tr>
<tr>
<td>$50,000</td>
</tr>
<tr>
<td>$10,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alternative 1 is</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher</td>
</tr>
<tr>
<td>Higher</td>
</tr>
<tr>
<td>Higher</td>
</tr>
<tr>
<td>Higher</td>
</tr>
</tbody>
</table>

^ $105,882 = ($450,000 ÷ $510,000) × $120,000.
^- $14,118 = ($60,000 ÷ $510,000) × $120,000.

The Differential Amount column in panel C of Figure 7.6 "Product Line Differential Analysis for Barbeque Company" indicates the company would be better off continuing with all three product lines. However, management may want a more concise explanation of why profit is $10,000 higher when all three product lines are maintained. We provide such an explanation in Figure 7.7 "Summary of Differential Analysis for Barbeque Company", which presents the Differential
Amount column shown in panel C of Figure 7.6 "Product Line Differential Analysis for Barbeque Company" along with a brief description for each item. Take a close look at panel C of Figure 7.6 "Product Line Differential Analysis for Barbeque Company", confirm that the Differential Amount column matches Figure 7.7 "Summary of Differential Analysis for Barbeque Company", and review the explanation of the difference.

**Figure 7.7 Summary of Differential Analysis for Barbeque Company**

<table>
<thead>
<tr>
<th>Result of Dropping Charcoal Barbecues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales revenue lost</td>
</tr>
<tr>
<td>Variable costs eliminated</td>
</tr>
<tr>
<td>Contribution margin eliminated</td>
</tr>
<tr>
<td>Direct fixed costs eliminated</td>
</tr>
<tr>
<td>Loss from dropping product line</td>
</tr>
<tr>
<td>$(90,000)</td>
</tr>
<tr>
<td>40,000</td>
</tr>
<tr>
<td>$(50,000)</td>
</tr>
<tr>
<td>40,000</td>
</tr>
<tr>
<td>$(10,000)</td>
</tr>
</tbody>
</table>

**Note:** Amounts shown in parentheses indicate a negative impact on profit, and amounts without parentheses indicate a positive impact on profit.

Figure 7.7 "Summary of Differential Analysis for Barbeque Company" shows that Barbeque Company will lose sales revenue of $90,000 if it drops the charcoal barbecues product line. However, it saves variable costs of $40,000 and direct fixed costs of $40,000 if it drops the charcoal barbecues product line. Because the $80,000 in cost savings is not enough to make up for the $90,000 loss in sales revenue, profit will decline by $10,000 ($80,000 − $90,000).

### Misleading Allocation of Fixed Costs

**Question:** How can the charcoal barbecues product line show a loss of $8,000 in Figure 7.6 "Product Line Differential Analysis for Barbeque Company", while the company as a whole is better off keeping this product line?
Answer: The answer lies within allocated fixed costs. Even though total allocated fixed costs of $120,000 cannot easily be traced to each product line, company management wants each product line manager to be aware of these costs. As a result, it uses an allocation process to assign the costs to product lines. Thus the charcoal barbecues product line is assigned $18,000 in allocated fixed costs even though these costs cannot be controlled by the product line. If the charcoal barbecues product line is eliminated, $18,000 in allocated fixed costs is not eliminated. Instead, $18,000 in costs is assigned to the other two product lines.

In many situations, this increased allocation to other product lines may cause other product lines to appear unprofitable. The message here is to be careful when analyzing segmented information containing cost allocations. Allocated costs are typically not differential costs, and therefore are typically not relevant to the decision.

An alternative view of the decision facing Barbeque Company—whether to keep or drop the charcoal barbecues product line—is simply to calculate profitability of this product line before deducting allocated fixed costs. Figure 7.6 "Product Line Differential Analysis for Barbeque Company" shows a contribution margin of $50,000 for charcoal barbecues. Deduct direct fixed costs of $40,000 and this product line has a remaining profit of $10,000. This explains why Barbeque Company’s overall profit would be $10,000 lower if the charcoal barbecues product line were eliminated. (As discussed previously, the allocated fixed costs are irrelevant to this decision.)

**Including Opportunity Costs in Differential Analysis**

Managers must often consider the impact of opportunity costs when making decisions. An opportunity cost is the benefit foregone when one alternative is selected over another. For example, assume you have the choice between going to school and working. The opportunity cost of attending school is the lost wages from working.

*Question:* In the case of Barbeque Company, assume the company can lease the space currently being used by the charcoal barbecues product line for $25,000 per year. Thus the opportunity
cost (benefit foregone) of keeping the charcoal barbecues is $25,000. How does this affect Barbeque Company’s decision to keep or drop charcoal barbecues?

Answer: Figure 7.8 "Differential Analysis with Opportunity Cost for Barbeque Company" provides the answer by simply adding one item to Figure 7.7 "Summary of Differential Analysis for Barbeque Company". Barbeque Company would increase profits $15,000 by dropping the charcoal barbecues.

Figure 7.8 Differential Analysis with Opportunity Cost for Barbeque Company

Note: Amounts shown in parentheses indicate a negative impact on profit, and amounts without parentheses indicate a positive impact on profit.

Opportunity costs can also be included in the differential analysis format presented in Figure 7.6 "Product Line Differential Analysis for Barbeque Company". Panel C of Figure 7.6 "Product Line Differential Analysis for Barbeque Company" is simply modified to reflect the opportunity cost, as shown.
Sunk Costs and Differential Analysis

Question: What is a sunk cost, and how do sunk costs affect differential analysis?

Answer: A sunk cost is a cost incurred in the past that cannot be changed by future decisions. For example, suppose Barbeque Company must dispose of store equipment related to the charcoal barbecues product line if charcoal barbecues are eliminated. The original cost of this store equipment is a sunk cost and should have no bearing on the decision whether to eliminate charcoal barbecues. As a general rule, sunk costs are not differential costs.

Business in Action 7.2

**Kmart Sells Stores**

The management of Kmart Corp., a mass merchandising company with more than 1,500 stores throughout the United States, agreed to sell 24 stores to Home Depot for $365 million in cash. Julian Day, Kmart’s president and chief executive officer, stated, “We will take advantage of opportunities to create value that include the sale of existing stores.”

In deciding whether to sell the stores, management likely considered the differential revenues and costs associated with keeping the stores versus selling them. Perhaps the stores were not profitable enough to exceed the $365 million in cash that Kmart received from the sale. Large retail companies with many widely dispersed stores commonly review their unprofitable stores on a regular basis and consider closing or selling stores that cannot turn a profit in the near future.


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**KEY TAKEAWAY**

- Managers often use differential analysis to determine whether to keep or drop a product line. Direct fixed costs are typically eliminated if a product line is eliminated, and are considered differential costs. Allocated fixed costs are typically not eliminated if a product line is eliminated, and are not differential costs. Managers compare sales revenue and costs for each alternative (keep or drop), and select the alternative with the highest profit.

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**REVIEW PROBLEM 7.3**

The following annual income statement is for Austin Appliances, Inc., a maker of electrical appliances:

<table>
<thead>
<tr>
<th>Product Lines</th>
<th>Blenders</th>
<th>Coffee Makers</th>
<th>Toasters</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales revenue</td>
<td>$750,000</td>
<td>$1,000,000</td>
<td>$250,000</td>
<td>$2,000,000</td>
</tr>
<tr>
<td>Variable costs</td>
<td>320,000</td>
<td>550,000</td>
<td>100,000</td>
<td>770,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$430,000</td>
<td>$450,000</td>
<td>$150,000</td>
<td>$1,030,000</td>
</tr>
<tr>
<td>Direct fixed costs</td>
<td>390,000</td>
<td>320,000</td>
<td>70,000</td>
<td>780,000</td>
</tr>
<tr>
<td>Allocated fixed costs</td>
<td>56,250</td>
<td>75,000</td>
<td>18,750</td>
<td>150,000</td>
</tr>
<tr>
<td>Profit (loss)</td>
<td>$(16,250)</td>
<td>$55,000</td>
<td>$61,250</td>
<td>$100,000</td>
</tr>
</tbody>
</table>

Austin Appliances is concerned about the losses associated with the blenders product line and is considering dropping this product line. Allocated fixed costs are assigned to product lines based on sales. For example, $56,250 in allocated fixed costs is allocated to the blenders product line based on the blenders product line sales as a percent of total sales ($56,250 = $150,000 x 56,250 / 1,000,000).

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Saylor URL: http://www.saylor.org/books
If Austin Appliances eliminates a product line, total allocated fixed costs are assigned to the remaining product lines. All variable costs and direct fixed costs are differential costs.

1. Using the differential analysis format presented in Figure 7.6 "Product Line Differential Analysis for Barbeque Company", determine whether Austin Appliances would be better off dropping the blenders product line or keeping the product line. Support your conclusion.

2. Assume Austin Appliances can lease the warehouse space currently being used by the blenders product line for $15,000 per year. How does this affect the company’s decision to keep or drop the blenders product line?

3. Summarize the result of dropping the blenders product line and leasing the warehouse space using the format presented in Figure 7.8 "Differential Analysis with Opportunity Cost for Barbeque Company".

Solution to Review Problem 7.3

1. As shown in the differential analysis given here, Austin Appliances would be better off keeping the blenders product line. Dropping this product line would result in a drop in total profit of $40,000.
2. The $15,000 opportunity cost of keeping all three product lines would not affect the company’s decision to keep the blenders product line. If the blenders are dropped, total profit will decrease by $40,000. Lease revenue of $15,000 is not enough to offset the $40,000 decrease in profit. In this scenario, total profit would decrease by $25,000 ($40,000 − $15,000). This result is presented formally, as follows:
3. Note: Amounts shown in parentheses indicate a negative impact on profit, and amounts without parentheses indicate a positive impact on profit.

7.4 Customer Decisions

Learning Objective

1. Use differential analysis to decide whether to keep or drop customers.

Question: Much like product line decisions, managers often use profitability as a determining factor to decide whether to keep or drop customers. This is an issue for all types of organizations, including manufacturers, retailers, and service companies. How does the differential analysis format differ for customer decisions compared to product line decisions?
1. Calculate the contribution margin per unit of constrained resource for each glove.

2. Which two gloves would Southside prefer to produce and sell to optimize the use of machine hours in the quality testing department?

Solution to Review Problem 7.8

1.

<table>
<thead>
<tr>
<th></th>
<th>Child Glove</th>
<th>Teen Glove</th>
<th>Adult Glove</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price per unit</td>
<td>$15</td>
<td>$20</td>
<td>$35</td>
</tr>
<tr>
<td>Variable cost per unit</td>
<td>$5</td>
<td>$8</td>
<td>$22</td>
</tr>
<tr>
<td>Contribution margin per unit</td>
<td>$10</td>
<td>$12</td>
<td>$13</td>
</tr>
<tr>
<td>Machine hours to perform quality test per unit</td>
<td>0.25</td>
<td>0.4</td>
<td>0.5</td>
</tr>
<tr>
<td>Contribution margin per machine hour</td>
<td>$40</td>
<td>$30</td>
<td>$26</td>
</tr>
</tbody>
</table>

2. The company would prefer to produce and sell the child and teen gloves, since these products have the highest contribution margin per machine hour.

7.9 Be Aware of Qualitative Factors

Learning Objective

1. Evaluate qualitative factors when using differential analysis.

Question: This chapter has focused on using relevant revenue and cost information to perform differential analysis. Using these quantitative factors to make decisions allows managers to support decisions with measurable data. For example, the idea of outsourcing production of wakeboards at Best Boards, Inc., presented at the beginning of the chapter, was rejected because it was more costly to outsource production of the boards than to produce them internally. Although using quantitative factors for decision making is important, management must also consider qualitative factors. How might the consideration of qualitative factors improve decisions made by managers?
Answer: Qualitative factors may outweigh the quantitative factors in making a decision. For example, assume management at Best Boards, Inc., believes there will be a decline in the market for wakeboards after next year. Outsourcing production makes it easier to quickly reduce costs in the face of a downturn by simply ordering fewer wakeboards from the supplier. Continuing to build the boards internally takes away this flexibility. The significant fixed costs often associated with manufacturing firms are difficult to reduce in the short run if production declines. Thus the qualitative factor of being able to reduce manufacturing costs quickly by outsourcing production may outweigh the quantitative factors shown in Figure 7.3 "Summary of Differential Analysis for Best Boards, Inc." and Figure 7.4 "Product Line Decision".

*Question:* What if the quantitative differential analysis for Best Boards had a different result, in that it showed the company should outsource? What qualitative factors should management consider before implementing this decision?

Answer: Management must consider whether product quality would remain the same. Financial stability of the producer must be considered as well. It does no good to outsource production and eliminate production facilities and employees if the producer being used suddenly shuts down. Also, employee morale tends to slide if employees in one segment of a company are fired. This can lead to an unhappy and inefficient workforce in other areas of the company, causing costs to rise. These are just a few of the qualitative factors that must be weighed against quantitative factors when performing differential analysis.

**KEY TAKEAWAY**

- Although accountants are responsible for providing relevant and objective financial information to help managers make decisions, qualitative factors also play a significant role in the decision-making process.

**REVIEW PROBLEM 7.9**

What qualitative factors should management consider when deciding whether to outsource production or keep production within the company?

Solution to Review Problem 7.9