

Although sales have remained unchanged at \$100,000, the sales mix is exactly the reverse of what it was in Exhibit 6-4, with the bulk of the sales now coming from the less profitable Le Louvre DVD. Notice that this shift in the sales mix has caused both the overall CM ratio and total profits to drop sharply from the prior month even though total sales are the same. The overall CM ratio dropped from 45% to only 30% in October, and net operating income has dropped from \$18,000 to only \$3,000. In addition, with the drop in the overall CM ratio, the company's break-even point is no longer \$60,000 in sales. Because the company is now realizing less average contribution margin per dollar of sales, it takes more sales to cover the same amount of fixed costs. Thus, the break-even point has increased from \$60,000 to \$90,000 in sales per year.

In preparing a break-even analysis, an assumption must be made concerning the sales mix. Usually the assumption is that it will not change. However, if the sales mix is expected to change, then this must be explicitly considered in any CVP computations.

IN BUSINESS

PLAYING THE CVP GAME

In 2002, General Motors (GM) gave away almost \$2,600 per vehicle in customer incentives such as price cuts and 0% financing. "The pricing sacrifices have been more than offset by volume gains, most of which have come from trucks and SUVs, like the Chevy Suburban and the GMC Envoy, which generate far more profit for the company than cars. Lehman Brothers analysts estimate that GM will sell an additional 395,000 trucks and SUVs and an extra 75,000 cars in 2002. The trucks, however, are the company's golden goose, hauling in an average [contribution margin] . . . of about \$7,000, compared with just \$4,000 for the cars. All told, the volume gains could bring in an additional \$3 billion [in profits]."

Source: Janice Revell, "GM's Slow Leak," *Fortune*, October 28, 2002, pp. 105-110.

Assumptions of CVP Analysis

A number of assumptions commonly underlie CVP analysis:

1. Selling price is constant. The price of a product or service will not change as volume changes.
2. Costs are linear and can be accurately divided into variable and fixed elements. The variable element is constant per unit, and the fixed element is constant in total over the entire relevant range.
3. In multiproduct companies, the sales mix is constant.
4. In manufacturing companies, inventories do not change. The number of units produced equals the number of units sold.

While these assumptions may be violated in practice, the results of CVP analysis are often "good enough" to be quite useful. Perhaps the greatest danger lies in relying on simple CVP analysis when a manager is contemplating a large change in volume that lies outside of the relevant range. For example, a manager might contemplate increasing the level of sales far beyond what the company has ever experienced before. However, even in these situations the model can be adjusted as we have done in this chapter to take into account anticipated changes in selling prices, fixed costs, and the sales mix that would otherwise violate the assumptions mentioned above. For example, in a decision that would affect fixed costs, the change in fixed costs can be explicitly taken into account as illustrated earlier in the chapter in the Acoustic Components example on pages 242-245.

Managerial Accounting

ysis is based on a **cost-volume-profit** model. This model can be used to answer a variety of critical questions such as what is the company's break-even volume, what is its margin of safety, and what will likely to happen if specific changes are made in prices, costs, and volume.

A CVP graph depicts the relationships between unit sales on the one hand and fixed expenses, variable expenses, total sales, and profits on the other hand. The profit graph is simpler than the CVP graph and shows how profits depend on sales. The CVP and profit graphs are useful for developing intuition about how costs and profits respond to changes in sales.

The contribution margin ratio is the ratio of the total contribution margin to total sales. This ratio can be used to quickly estimate what impact a change in total sales would have on net operating income. The ratio is also useful in break-even analysis.

Target profit analysis is used to estimate how much sales would have to be to attain a specified target profit. The unit sales required to attain the target profit can be estimated by dividing the sum of the target profit and fixed expense by the unit contribution margin. Break-even analysis is a special case of target profit analysis that is used to estimate how much sales would have to be to just break even. The unit sales required to break even can be estimated by dividing the fixed expense by the unit contribution margin.

The margin of safety is the amount by which the company's current sales exceeds break-even sales.

The degree of operating leverage allows quick estimation of what impact a given percentage change in sales would have on the company's net operating income. The higher the degree of operating leverage, the greater is the impact on the company's profits. The degree of operating leverage is not constant—it depends on the company's current level of sales.

The profits of a multiproduct company are affected by its sales mix. Changes in the sales mix can affect the break-even point, margin of safety, and other critical factors.

Review Problems: CVP Relationships

Voltar Company manufactures and sells a specialized cordless telephone for high electromagnetic radiation environments. The company's contribution format income statement for the most recent year is given below:

| | Total | Per Unit | Percent of Sales |
|----------------------------|------------------|----------|------------------|
| Sales (20,000 units) | \$1,200,000 | \$60 | 100% |
| Variable expenses | 900,000 | 45 | ? % |
| Contribution margin | 300,000 | \$15 | ? % |
| Fixed expenses | 240,000 | | |
| Net operating income | <u>\$ 60,000</u> | | |

Management is anxious to increase the company's profit and has asked for an analysis of a number of items.

Required:

1. Compute the company's CM ratio and variable expense ratio.
2. Compute the company's break-even point in both units and sales dollars. Use the equation method.
3. Assume that sales increase by \$400,000 next year. If cost behavior patterns remain unchanged, by how much will the company's net operating income increase? Use the CM ratio to compute your answer.
4. Refer to the original data. Assume that next year management wants the company to earn a profit of at least \$90,000. How many units will have to be sold to meet this target profit?
5. Refer to the original data. Compute the company's margin of safety in both dollar and percentage form.

Chapter 6

6. a. Compute the company's degree of operating leverage at the present level of sales.
 b. Assume that through a more intense effort by the sales force, the company's sales increase by 8% next year. By what percentage would you expect net operating income to increase? Use the degree of operating leverage to obtain your answer.
 c. Verify your answer to (b) by preparing a new contribution format income statement showing an 8% increase in sales.
7. In an effort to increase sales and profits, management is considering the use of a higher-quality speaker. The higher-quality speaker would increase variable costs by \$3 per unit, but management could eliminate one quality inspector who is paid a salary of \$30,000 per year. The sales manager estimates that the higher-quality speaker would increase annual sales by at least 20%.
- a. Assuming that changes are made as described above, prepare a projected contribution format income statement for next year. Show data on a total, per unit, and percentage basis.
 b. Compute the company's new break-even point in both units and dollars of sales. Use the formula method.

Would you recommend that the changes be made?

Solution to Review Problem

1.

$$\text{CM ratio} = \frac{\text{Unit contribution margin}}{\text{Unit selling price}} = \frac{\$15}{\$60} = 25\%$$

$$\text{Variable expense ratio} = \frac{\text{Variable expense}}{\text{Selling price}} = \frac{\$45}{\$60} = 75\%$$

2.

$$\text{Profit} = \text{Unit CM} \times Q - \text{Fixed expenses}$$

$$\$0 = (\$60 - \$45) \times Q - \$240,000$$

$$\$15Q = \$240,000$$

$$Q = \$240,000 \div \$15$$

$$Q = 16,000 \text{ units; or at } \$60 \text{ per unit, } \$960,000$$

3.

| | |
|------------------------------------------------|-------------------------|
| Increase in sales | \$400,000 |
| Multiply by the CM ratio | $\times 25\%$ |
| Expected increase in contribution margin | <u><u>\$100,000</u></u> |

Because the fixed expenses are not expected to change, net operating income will increase by the entire \$100,000 increase in contribution margin computed above.

4. Equation method:

$$\text{Profit} = \text{Unit CM} \times Q - \text{Fixed expenses}$$

$$\$90,000 = (\$60 - \$45) \times Q - \$240,000$$

$$\$15Q = \$90,000 + \$240,000$$

$$Q = \$330,000 \div \$15$$

$$Q = 22,000 \text{ units}$$

5. Margin of safety in dollars = Total sales - Break-even sales

$$= \$1,200,000 - \$960,000 = \$240,000$$

$$\text{Margin of safety percentage} = \frac{\text{Margin of safety in dollars}}{\text{Total sales}} = \frac{\$240,000}{\$1,200,000} = 20\%$$

6. a. Degree of operating leverage = $\frac{\text{Contribution margin}}{\text{Net operating income}} = \frac{\$300,000}{\$60,000} = 5$
- b.

| | |
|------------------------------------------------|-------------------|
| Expected increase in sales | 8% |
| Degree of operating leverage | $\times 5$ |
| Expected increase in net operating income..... | <u><u>40%</u></u> |

- c. If sales increase by 8%, then 21,600 units ($20,000 \times 1.08 = 21,600$) will be sold next year. The new contribution format income statement would be as follows:

| | Total | Per Unit | Percent of Sales |
|----------------------------|------------------------|-----------|------------------|
| Sales (21,600 units) | \$1,296,000 | \$60 | 100% |
| Variable expenses | 972,000 | 45 | <u>75%</u> |
| Contribution margin | 324,000 | <u>15</u> | <u>25%</u> |
| Fixed expenses | <u>240,000</u> | | |
| Net operating income | <u><u>\$84,000</u></u> | | |

Thus, the \$84,000 expected net operating income for next year represents a 40% increase over the \$60,000 net operating income earned during the current year:

$$\frac{\$84,000 - \$60,000}{\$60,000} = \frac{\$24,000}{\$60,000} = 40\% \text{ increase}$$

Note from the income statement above that the increase in sales from 20,000 to 21,600 units has increased both total sales and total variable expenses.

7. a. A 20% increase in sales would result in 24,000 units being sold next year: $20,000 \text{ units} \times 1.20 = 24,000 \text{ units}$.

| | Total | Per Unit | Percent of Sales |
|----------------------------|-------------------------|-----------|------------------|
| Sales (24,000 units) | \$1,440,000 | \$60 | 100% |
| Variable expenses | 1,152,000 | 48* | <u>80%</u> |
| Contribution margin | 288,000 | <u>12</u> | <u>20%</u> |
| Fixed expenses | <u>210,000†</u> | | |
| Net operating Income | <u><u>\$ 78,000</u></u> | | |

*\$45 + \$3 = \$48; \$48 ÷ \$60 = 80%.

†\$240,000 - \$30,000 = \$210,000.

Note that the change in per unit variable expenses results in a change in both the per unit contribution margin and the CM ratio.

b. Unit sales to break even = $\frac{\text{Fixed expenses}}{\text{Unit contribution margin}}$

$$= \frac{\$210,000}{\$12 \text{ per unit}} = 17,500 \text{ units}$$

Chapter 6

EXERCISE 6-6 Compute the Level of Sales Required to Attain a Target Profit [LO5]

Lin Corporation has a single product whose selling price is \$120 and whose variable expense is \$80 per unit. The company's monthly fixed expense is \$50,000.

Required:

1. Using the equation method, solve for the unit sales that are required to earn a target profit of \$10,000.
2. Using the formula method, solve for the unit sales that are required to earn a target profit of \$15,000.



EXERCISE 6-7 Compute the Break-Even Point [LO6]

Mauro Products distributes a single product, a woven basket whose selling price is \$15 and whose variable expense is \$12 per unit. The company's monthly fixed expense is \$4,200.

Required:

1. Solve for the company's break-even point in unit sales using the equation method.
2. Solve for the company's break-even point in sales dollars using the equation method and the CM ratio.
3. Solve for the company's break-even point in unit sales using the formula method.
4. Solve for the company's break-even point in sales dollars using the formula method and the CM ratio.



EXERCISE 6-8 Compute the Margin of Safety [LO7]

Molander Corporation is a distributor of a sun umbrella used at resort hotels. Data concerning the next month's budget appear below:

| | |
|----------------------|-----------------------|
| Selling price | \$30 per unit |
| Variable expenses .. | \$20 per unit |
| Fixed expenses | \$7,500 per month |
| Unit sales | 1,000 units per month |

Required:

1. Compute the company's margin of safety.
2. Compute the company's margin of safety as a percentage of its sales.



EXERCISE 6-9 Compute and Use the Degree of Operating Leverage [LO8]

Engberg Company installs lawn sod in home yards. The company's most recent monthly contribution format income statement follows:

| | Amount | Percent of Sales |
|----------------------------|-----------------|------------------|
| Sales | \$80,000 | 100% |
| Variable expenses | 32,000 | 40% |
| Contribution margin | 48,000 | 60% |
| Fixed expenses | 38,000 | |
| Net operating income | <u>\$10,000</u> | |

Required:

1. Compute the company's degree of operating leverage.
2. Using the degree of operating leverage, estimate the impact on net operating income of a 5% increase in sales.
3. Verify your estimate from part (2) above by constructing a new contribution format income statement for the company assuming a 5% increase in sales.



EXERCISE 6-10 Compute the Break-Even Point for a Multiproduct Company [LO9]

Lucido Products markets two computer games: Claimjumper and Makeover. A contribution format income statement for a recent month for the two games appears on the following page:

Cost Volume Profit Relationships

| | Claimjumper | Makover | Total |
|----------------------------|-----------------|-----------------|-----------------|
| Sales..... | \$30,000 | \$70,000 | \$100,000 |
| Variable expenses | 20,000 | 50,000 | 70,000 |
| Contribution margin | <u>\$10,000</u> | <u>\$20,000</u> | 30,000 |
| Fixed expenses | | | 24,000 |
| Net operating income | | | <u>\$ 6,000</u> |

Required:

1. Compute the overall contribution margin (CM) ratio for the company.
2. Compute the overall break-even point for the company in sales dollars.
3. Verify the overall break-even point for the company by constructing a contribution format income statement showing the appropriate levels of sales for the two products.

EXERCISE 6-11 Using a Contribution Format Income Statement [LO1, LO4]

Miller Company's most recent contribution format income statement is shown below:

| | Total | Per Unit |
|----------------------------|------------------|----------------|
| Sales (20,000 units) | \$300,000 | \$15.00 |
| Variable expenses | 180,000 | 9.00 |
| Contribution margin | 120,000 | <u>\$ 6.00</u> |
| Fixed expenses..... | <u>70,000</u> | |
| Net operating income | <u>\$ 50,000</u> | |



Required:

Prepare a new contribution format income statement under each of the following conditions (consider each case independently):

1. The number of units sold increases by 15%.
2. The selling price decreases by \$1.50 per unit, and the number of units sold increases by 25%.
3. The selling price increases by \$1.50 per unit, fixed expenses increase by \$20,000, and the number of units sold decreases by 5%.
4. The selling price increases by 12%, variable expenses increase by 60 cents per unit, and the number of units sold decreases by 10%.



EXERCISE 6-12 Target Profit and Break-Even Analysis; Margin of Safety; CM Ratio [LO1, LO3, LO5, LO6, LO7]

Menlo Company distributes a single product. The company's sales and expenses for last month follow:

| | Total | Per Unit |
|----------------------------|------------------|-------------|
| Sales..... | \$450,000 | \$30 |
| Variable expenses | 180,000 | 12 |
| Contribution margin | 270,000 | <u>\$18</u> |
| Fixed expenses..... | <u>216,000</u> | |
| Net operating income | <u>\$ 54,000</u> | |



Required:

1. What is the monthly break-even point in units sold and in sales dollars?
2. Without resorting to computations, what is the total contribution margin at the break-even point?
3. How many units would have to be sold each month to earn a target profit of \$90,000? Use the formula method. Verify your answer by preparing a contribution format income statement at the target sales level.

Answer