

# 21. Cost-volume-profit analysis

## Learning objectives

After studying this chapter, you should be able to:

- Explain and describe cost behavior patterns.
- Separate mixed costs into fixed and variable components using the scatter diagram and high-low method.
- Explain the relationship among costs, volume, revenue, and profits.
- Find the break-even point.
- Compute the margin of safety.
- Demonstrate applications of cost-volume-profit analysis.
- List the assumptions underlying cost-volume-profit analysis.
- Describe how computer spreadsheets expand your capability to use cost-volume-profit analysis.
- Describe the impact of automation on fixed-variable cost relationships.

## A manager's perspective

### **Renee Vaughn**

*Manager, Administration and Special Projects*

*Public and Media Relations*

*The Coca-Cola Company*

I am responsible for providing scheduling and assisting with staffing with the Public and Media Relations group. This requires anticipating needs for the group and planning accordingly. I also administer budgets for three departments (about 35 employees).

I began my professional career in an elementary school district administration office, serving as an administrative assistant for the superintendent of schools. I learned to plan and manage budgets in that capacity. At The Coca-Cola Company, once a budget is created at the departmental level, it is tracked on a monthly basis by reviewing all spending by account and in total. We also review a rolling estimate of annual expenses and adjust the budget accordingly.

We plan for non-project capital budgeting a year in advance, which enables us to order computer, fax, and other office equipment as well as make other necessary major purchases. If an unforeseen need develops, we will review our plan and make revisions as necessary on a case-by-case basis.

## 21. Cost-volume-profit analysis

Assume that a student organization wants to show movies on campus. The organization can rent a particular movie for one weekend for USD 1,000. Rent for an auditorium, salaries for ticket takers and other personnel, and other fixed costs would amount to USD 800 for the weekend. The organization would sell tickets for USD 4 per person. In addition, profits from the sale of soft drinks, popcorn, and candy are estimated to be USD 1 per ticket holder. How many people would have to buy tickets to justify renting the movie? (The answer is 360 ticket-buyers as shown in the solution to Demonstration problem at the end of this chapter.)

Solving problems like this requires an understanding of the relationship between costs, revenue, and volume. This chapter discusses the use of cost-volume-profit analysis for decision making and planning. (Although accountants call this topic cost-volume-profit analysis, it could just as easily have been called cost-volume- revenue analysis.) All of the analysis in this chapter is on a before-tax basis.

In this chapter we will focus on short-run decisions. The term **short run** describes a time frame during which a company's management cannot change the effects of certain past decisions. The short run is one year or less for practical purposes. For example, GM's decision to offer a special rebate starting January 5 and expiring on January 31 would be a short-run decision. In contrast, GM's decision to begin producing cars in China .

In the short run, we assume many costs are fixed and unchangeable, such as building rental expense. However, all costs are subject to change in the long run. Although we identify particular costs as fixed in this chapter, you should realize that costs fixed in the short run may change in the long run. Someday the building rental agreement will change, so the building rental expense will change.

### Cost behavior patterns

Exhibit 17 shows four basic cost behavior patterns: fixed, variable, mixed (semivariable), and step. As discussed in earlier chapters, **fixed costs** remain constant (in total) over some relevant range of output. Often, we describe them as time-related costs. Depreciation, insurance, property taxes, and administrative salaries are examples of fixed costs. Recall that so-called fixed costs are fixed in the short run but not necessarily in the long run.

For example, a local high-tech company did not lay off employees during a recent decrease in business volume because the management did not want to hire and train new people when business picked up again. Management treated direct labor as a fixed cost in this situation. Although volume decreased, direct labor costs remained fixed.

**Illustration 21.1 Four Cost Patterns**

**Reinforcing Problem**  
E21-1 Match cost behavior types with diagrams

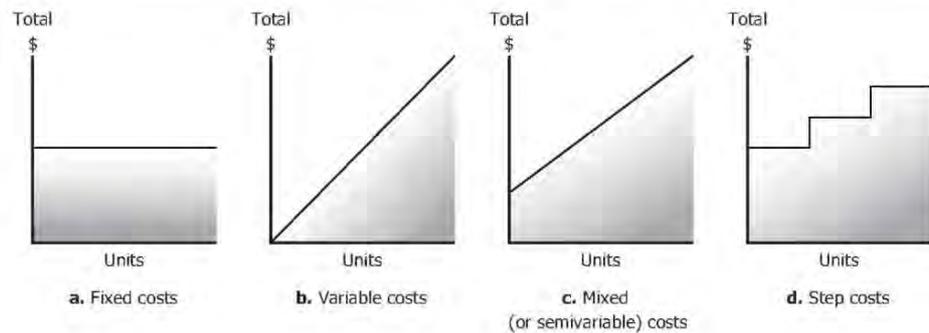


Exhibit 17: Four cost patterns

In contrast to fixed costs, **variable costs** vary (in total) directly with changes in volume of production or sales. In particular, total variable costs change as total volume changes. If pizza production increases from 100 10-inch pizzas to 200 10-inch pizzas per day, the amount of dough required per day to make 10-inch pizzas would double. The dough is a variable cost of pizza production. Direct materials and sales commissions are variable costs.

Direct labor is a variable cost in many cases. If the total direct labor cost increases as the volume of output increases and decreases as volume decreases, direct labor is a variable cost. Piecework pay is an excellent example of direct labor as a variable cost. In addition, direct labor is frequently a variable cost for workers paid on an hourly basis, as the volume of output increases, more workers are hired. However, sometimes the nature of the work or management policy does not allow direct labor to change as volume changes and direct labor can be a fixed cost.

Mixed costs have both fixed and variable characteristics. A **mixed cost** contains a fixed portion of cost incurred even when the facility is idle, and a variable portion that increases directly with volume. Electricity is an example of a mixed cost. A company must incur a certain cost for basic electrical service. As the company increases its volume of activity, it runs more machines and runs them longer. The firm also may extend its hours of operation. As activity increases, so does the cost of electricity.

Managers usually separate mixed costs into their fixed and variable components for decision-making purposes. They include the fixed portion of mixed costs with other fixed costs, while assuming the variable part changes with volume. Look at Exhibit 18 to see how to separate the fixed and variable portions of a mixed cost such as electricity.

## 21. Cost-volume-profit analysis

### Illustration 21.2 Separation of Mixed Costs into Fixed and Variable Parts

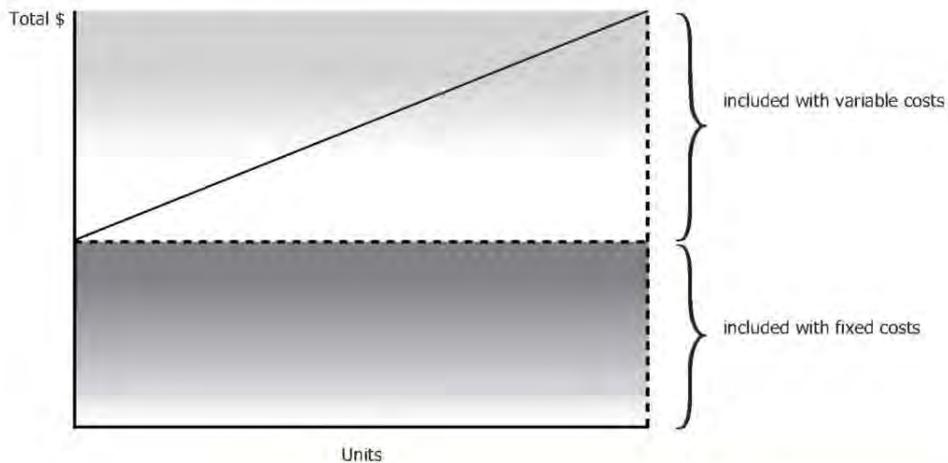


Exhibit 18: Separation of mixed costs into fixed and variable parts

A **step cost** remains constant at a certain fixed amount over a range of output (or sales). Then, at certain points, the step costs increase to higher amounts. Visually, step costs appear like stair steps, as shown in Exhibit 17.

Supervisors' salaries are an example of a step cost when companies hire additional supervisors as production increases. For instance, the local McDonald's restaurant has one supervisor until sales exceed 100 meals during the lunch hour. If sales regularly exceed 100 meals during that hour, the company adds a second supervisor. In Exhibit 19, we show a step cost for supervisors' salaries, assuming each supervisor is paid USD 2,000 per month. Step costs are sometimes labeled as step variable costs (many small steps) or step fixed costs (only a few large steps).

### Illustration 21.3 A Step Cost

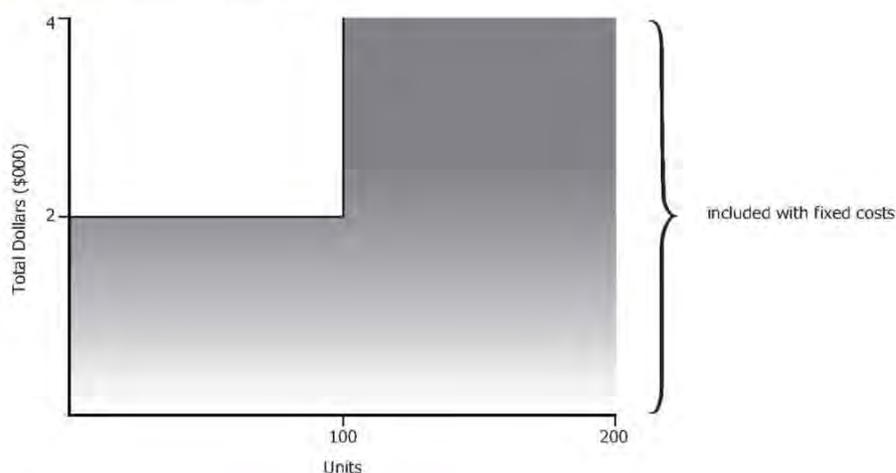


Exhibit 19: A step cost

Although we have described four different cost patterns (fixed, variable, mixed, and step), we simplify our discussions in this chapter by assuming managers can separate mixed and step costs into fixed and variable components.

Many costs do not vary in a strictly linear relationship with volume. Rather, costs may vary in a curvilinear pattern—a 10 per cent increase in volume may yield an 8 per cent change in total variable costs at lower output levels and an 11 per cent change in total variable costs at higher output levels. We show a curvilinear cost pattern in Exhibit 20.

Illustration 21.4 Curvilinear Cost Pattern

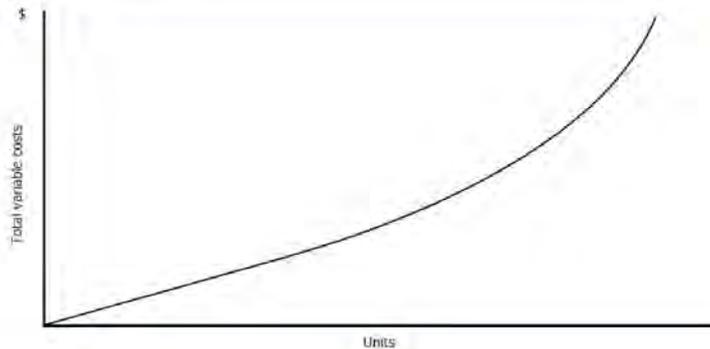


Exhibit 20: Curvilinear cost pattern

One way to deal with a curvilinear cost pattern is to assume a linear relationship between costs and volume within some relevant range. The **relevant range** is the range of production or sales volume over which the assumptions about cost behavior are valid. Look at Exhibit 21 to see how to apply the relevant range to a portion of the curvilinear cost curve. Within that relevant range, the total cost varies linearly with volume, at least approximately. Outside of the relevant range, we presume the assumptions about cost behavior may be invalid.

Illustration 21.5 Relevant Range

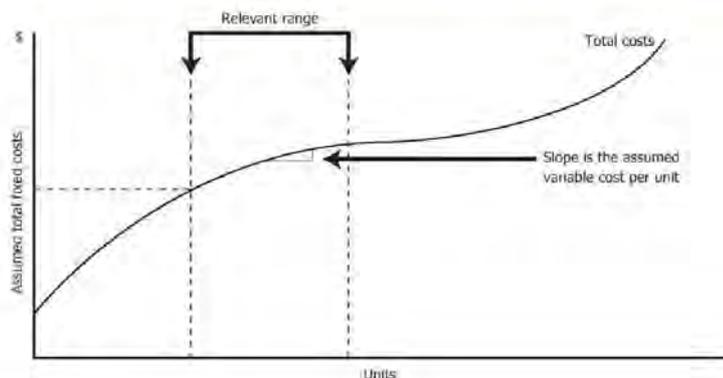


Exhibit 21: Relevant range

## 21. Cost-volume-profit analysis

Costs rarely behave in the simple way that would make life easy for decision makers. Even within the relevant range, the assumed cost behavior is usually only approximately linear. As decision makers, we have to live with the fact that cost estimates are not as precise as physical or engineering measurements.

### Methods for analyzing costs

You can use several methods to break down a mixed cost into its fixed and variable cost components. We present two of these methods—the scatter diagram and the high-low method.

A **scatter diagram** shows plots of actual costs incurred for various levels of activity. Assume the dots on the scatter diagram in Exhibit 22 represent total actual maintenance costs per month for a Federal Express fleet of delivery trucks. Each dot represents one month's activity for one city. For example, the left point represents a USD 38,000 cost for approximately 30,000 miles a month. The next point to the right represents USD 42,000 for approximately 40,000 miles for another month. We drew a line that appears to best fit the pattern of dots. The line we drew is subjective. If you were to draw such a line, your line would probably differ from ours.

Estimating fixed and variable costs using a scatter diagram is subjective. If your line through the dots in Exhibit 22 differs from ours, you would estimate different fixed and variable costs. Your line and cost estimates would not necessarily be right or wrong compared to ours, just different.

**Illustration 21.6** Scatter Diagram

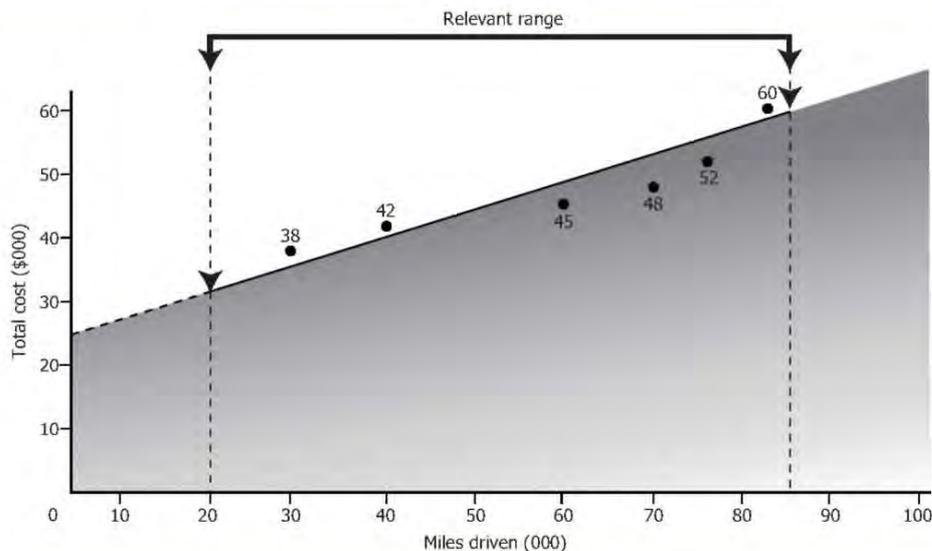


Exhibit 22: Scatter diagram

In Exhibit 22, our line intersects the vertical axis at USD 25,000, which we estimate to be the fixed portion of the mixed cost. We estimate the line would pass through a point representing a cost of USD 57,000 at a volume of 80,000 miles. Thus, our line rises from USD 25,000, representing 0 (zero) miles, to USD 57,000 over a volume of 80,000 miles on the horizontal axis. Based on that information, we can now compute the variable cost portion of the mixed cost as follows:

$$\frac{\text{USD } 57,000 - \text{USD } 25,000}{80,000 \text{ miles} - 0 \text{ miles}} = \text{USD } 0.40 \text{ per mile}$$

Using this result, we estimate the company's truck maintenance costs are USD 25,000 per month plus 40 cents for every mile driven.

You can also use the **high-low method** to identify the elements of mixed costs. This method uses only the highest and lowest points (levels of operation) on a scatter diagram to fit a line to the data.

To illustrate, the lowest point in Exhibit 22, is USD 38,000 of expense at 30,000 miles driven, and the highest point is USD 60,000 at 80,000 miles. Calculate the amount of variable cost per mile as follows:

$$\frac{\text{Change for cost}}{\text{Change for units}} = \frac{\text{USD } 60,000 - \text{USD } 38,000}{80,000 \text{ miles} - 30,000 \text{ miles}} = \frac{\text{USD } 22,000}{50,000 \text{ miles}} = \text{USD } 0.44 \text{ per mile}$$

To compute the fixed portion:

Total cost at 80,000 miles	\$60,000
Less: Variance cost at that level of output (80,000 x \$0.44)	35,200
Fixed cost at all levels of mileage within the relevant range	\$24,800

The high-low method is less precise than the scatter diagram because it uses only two data points in the computation. Either or both points may not be representative of the data as a whole.

Many people use more sophisticated statistical techniques to divide mixed costs into fixed and variable portions. Statistics and cost accounting texts discuss these techniques.

Now that you understand cost patterns and how to analyze costs, we will apply these concepts to the specific tools that managers use in short-term decision making. The first of these tools is cost-volume-profit (CVP) analysis.

### Cost-volume-profit (CVP) analysis

Companies use **cost-volume-profit (CVP) analysis** (also called break-even analysis) to determine what affects changes in their selling prices, costs, and/or volume will have on profits in the short run. A careful and accurate cost-volume-profit (CVP) analysis requires knowledge of costs and their fixed or variable behavior as volume changes.

A **cost-volume-profit chart** is a graph that shows the relationships among sales, costs, volume, and profit. Look at Exhibit 23, a cost-volume-profit chart for Video Productions, a company that produces videotapes. Each tape sells for USD 20. The variable cost per tape is USD 12, and the fixed costs per month are USD 40,000.

The total cost line in Exhibit 23 represents the fixed costs of USD 40,000 plus USD 12 per unit. Thus, if Video Productions produces and sells 6,000 tapes, the company's total costs are USD 112,000, made up of USD 40,000 fixed costs and USD 72,000 total variable costs (USD 72,000 = USD 12 per unit X 6,000 units produced and sold).

The total revenue line in Exhibit 23 shows how revenue increases as volume increases. Total revenue is USD 120,000 for sales of 6,000 tapes (USD 120,000 = USD 20 per unit X 6,000 units sold). In Exhibit 23, we demonstrate the effect of volume on revenue, costs, and net income, for a particular price, variable cost per unit, and fixed cost per period.

## 21. Cost-volume-profit analysis

**Illustration 21.7 The Cost-Volume-Profit Chart**

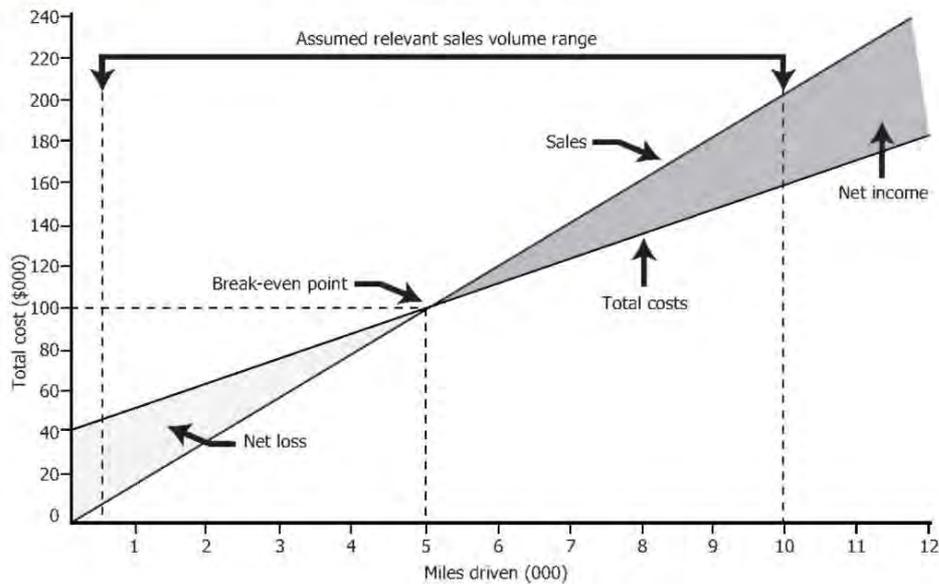


Exhibit 23: The cost-volume-profit chart

At each volume, one can estimate the company's profit or loss. For example, at a volume of 6,000 units, the profit is USD 8,000. We can find the net income either by constructing an income statement or using the profit equation. The income statement gives the following results for a volume of 6,000 units:

Revenue	\$120,000
Less: variable costs	72,000
Contribution margin	\$ 48,000
Less: Fixed costs	40,000
Net income	\$ 8,000

We have introduced a new term in this income statement—the contribution margin. The **contribution margin** is the amount by which revenue exceeds the variable costs of producing that revenue. We can calculate it on a per unit or total sales volume basis. On a per unit basis, the contribution margin for Video Productions is USD 8 (the selling price of USD 20 minus the variable cost per unit of USD 12).

The contribution margin indicates the amount of money remaining after the company covers its variable costs. This remainder contributes to the coverage of fixed costs and to net income. In Video Production's income statement, the USD 48,000 contribution margin covers the USD 40,000 fixed costs and leaves USD 8,000 in net income.

**Profit equation** The profit equation is just like the income statement, except it presents the analysis in a slightly different form. According to the **profit equation**:

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

For Video Productions, the profit equation looks like this:

$$\text{Net income} = \text{USD } 120,000 - \text{USD } 72,000 - \text{USD } 40,000$$

Net income=USD8,000

Exhibit 23 shows cost data for Video Productions in a relevant range of output from 500 to 10,000 units. Recall the relevant range is the range of production or sales volume over which the basic cost behavior assumptions hold true. For volumes outside these ranges, costs behave differently and alter the assumed relationships. For example, if Video Productions produced and sold more than 10,000 units per month, it might be necessary to increase plant capacity (thus incurring additional fixed costs) or to work extra shifts (thus incurring overtime charges and other inefficiencies). In either case, the assumed cost relationships would no longer be valid.

### Finding the break-even point

A company breaks even for a given period when sales revenue and costs charged to that period are equal. Thus, the **break-even point** is that level of operations at which a company realizes no net income or loss.

A company may express a break-even point in dollars of sales revenue or number of units produced or sold. No matter how a company expresses its break-even point, it is still the point of zero income or loss. To illustrate the calculation of a break-even point, recall that Video Productions produces videotapes selling for USD 20 per unit. Fixed costs per period total USD 40,000, while variable cost is USD 12 per unit.

**Break-even in units** We compute the break-even point in units by dividing total fixed costs by the contribution margin per unit. The contribution margin per unit is USD 8 (USD 20 selling price per unit - USD 12 variable cost per unit). In the following break-even equation, BE refers to the break-even point:

$$\text{BE units} = \frac{\text{Fix costs}}{\text{Contribution margin per unit}}$$

$$\text{BE units} = \frac{\text{USD } 40,000}{\text{USD } 8 \text{ per unit}}$$

$$\text{BE units} = 5,000 \text{ units}$$

The result tells us that Video Productions breaks even at a volume of 5,000 units per month. We can prove that to be true by computing the revenue and total costs at a volume of 5,000 units. Revenue = 5,000 units X USD 20 sales price per unit = USD 100,000. Total costs = USD 100,000 = USD 40,000 fixed costs + USD 60,000 variable costs (USD 60,000 = USD 12 per unit X 5,000 units).

Look at Exhibit 23 and note that the revenue and total cost lines cross at 5,000 units—the break-even point. Video Productions has net income at volumes greater than 5,000, but it has losses at volumes less than 5,000 units.

**Break-even in sales dollars** Companies frequently think of volume in sales dollars instead of units. For a company such as GM that makes Cadillacs and certain small components, it makes no sense to think of a break-even point in units. GM breaks even in sales dollars.

The formula to compute the break-even point in sales dollars looks a lot like the formula to compute the break-even in units, except we divide fixed costs by the contribution margin ratio instead of the contribution margin per unit.

$$\text{BE dollars} = \frac{\text{Fix costs}}{\text{Contribution margin ratio}}$$

## 21. Cost-volume-profit analysis

### A broader perspective: Even colleges use CVP

The dean of the Business School at a particular university was considering whether to offer a seminar for executives. The tuition would be USD 650 per person. Variable costs, including meals, parking, and materials, would be USD 80 per person. Certain costs of offering the seminar, including advertising, instructors' fees, room rent, and audiovisual equipment rent, would not be affected by the number of people attending (within a "relevant range"). Such costs, which could be thought of as fixed costs, amounted to USD 8,000 for the seminar.

In addition to these costs, a number of staff, including the dean, would work on the program. Although the salaries paid to these staff were not affected by offering the seminar, working on it took these people away from other duties, thus creating an opportunity cost, estimated to be USD 7,000 for this seminar.

Given this information, the school estimated the break-even point to be  $(\text{USD } 8,000 + \text{USD } 7,000) / (\text{USD } 650 - \text{USD } 80) = 26.3$  students. If the school wanted at least to break even on this program, it should offer the program only if it expected at least 27 students to attend.

Based on the authors' research.

The **contribution margin ratio** expresses the contribution margin as a percentage of sales. To calculate this ratio, divide the contribution margin per unit by the selling price per unit, or total contribution margin by total revenues. Video Production's contribution margin ratio is:

$$\text{Contribution margin ratio} = \frac{\text{Contribution margin per unit}}{\text{Selling price per unit}}$$

$$\frac{\text{USD } 20 - \text{USD } 12}{\text{USD } 20} = \frac{\text{USD } 8}{\text{USD } 20}$$

$$= 0.40$$

Or, referring to the income statement in which Video Productions had a total contribution margin of USD 48,000 on revenues of USD 120,000, we compute the contribution margin ratio as follows:

$$\text{Contribution margin ratio} = \frac{\text{Total contribution margin}}{\text{Total revenues}}$$

$$= \frac{\text{USD } 48,000}{\text{USD } 120,000}$$

$$= 0.40$$

That is, for each dollar of sales, there is a USD 0.40 contribution to covering fixed costs and generating net income.

Using this ratio, we calculate Video Production's break-even point in sales dollars as:

$$\text{BE dollars} = \frac{\text{Fix costs}}{\text{Contribution margin rate}}$$

$$\text{BE dollars} = \frac{\text{USD } 40,000}{0.40}$$

$$= \text{USD } 100,000$$

The break-even volume of sales is USD 100,000 (5,000 units at USD 20 per unit). At this level of sales, fixed costs plus variable costs equal sales revenue, as shown here:

Revenue	\$120,000
Less: variable costs	72,000
Contribution margin	\$ 48,000
Less: Fixed costs	40,000
Net income	\$ 8,000

The cost-volume-profit chart in Exhibit 23 shows that in a period of complete idleness, Video Productions would lose USD 40,000 (the amount of fixed costs). However, when Video Productions has an output of 10,000 units, the company has net income of USD 40,000. Other points on the graph show that sales of 7,500 units results in USD 150,000 of revenue. At that point, Video Production's total costs amount to USD 130,000, leaving net income of USD 20,000.

Although you are likely to use cost-volume-profit analysis for a single product, you will more frequently use it in multi-product situations. The easiest way to use cost-volume-profit analysis for a multi-product company is to use dollars of sales as the volume measure. For CVP purposes, a multi-product company must assume a given product mix. **Product mix** refers to the proportion of the company's total sales attributable to each type of product sold.

To illustrate the computation of the break-even point for Wonderfood, a multi-product company that makes three types of cereal, assume the following historical data:

	Product							
	1		2		3		Total	
	Amount	Per cent	Amount	Per cent	Amount	Per cent	Amount	Per cent
Sales	\$60,000	100%	\$30,000	100%	\$10,000	100%	\$100,000	100%
Less:								
Variable costs	40,000	67%	16,000	53%	4,000	40%	60,000	60%
Contribution margin	\$20,000	33%	\$14,000	47%	\$ 6,000	60%	\$ 40,000	40%

We use the data in the total columns to compute the break-even point. The contribution margin ratio is 40 per cent or (USD 40,000/USD 100,000). Assuming the product mix remains constant and fixed costs for the company are USD 50,000, break-even sales are USD 125,000, computed as follows:

$$\text{BE dollars} = \frac{\text{Fix costs}}{\text{Contribution margin ratio}}$$

$$\text{BE dollars} = \frac{\text{USD } 50,000}{0.40}$$

$$= \text{USD } 125,000$$

[To check our answer: (USD 125,000 X 0.40) - USD 50,000 = USD 0.]

To find the three product sales totals, we multiply total sales dollars by the per cent of product mix for each of the three products. The product mix for products 1, 2, and 3 is 60:30:10, respectively. That is, out of the USD 100,000 total sales, there were sales of USD 60,000 for product 1, USD 30,000 for product 2, and USD 10,000 for

## 21. Cost-volume-profit analysis

product 3. Therefore, the company has to sell USD 75,000 of product 1 (0.6 X USD 125,000), USD 37,500 of product 2 (0.3 X USD 125,000), and USD 12,500 of product 3 (0.1 X USD 125,000) to break even.

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### An accounting perspective:

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#### Business insight

The founder of Domino's Pizza, Inc. nearly went bankrupt several times before he finally made Domino's a financial success. One early problem was that the company was providing small pizzas that cost almost as much to make and just as much to deliver as larger pizzas. Because they were small, the company could not charge enough to cover its costs. At one point, the company's founder was so busy producing small pizzas that he did not have time to determine that the company was losing money on them.

If a company's current sales are more than its break-even point, it has a margin of safety equal to current sales minus break-even sales. The **margin of safety** is the amount by which sales can decrease before the company incurs a loss. For example, assume Video Productions currently has sales of USD 120,000 and its break-even sales are USD 100,000. The margin of safety is USD 20,000, computed as follows:

$$\begin{aligned}\text{Margin safety} &= \text{Current sales} - \text{Break-even sales} \\ &= \text{USD } 120,000 - \text{USD } 100,000 \\ &= \text{USD } 20,000\end{aligned}$$

Sometimes people express the margin of safety as a percentage, called the margin of safety rate. The **margin of safety rate** is equal to  $\frac{(\text{Current sales} - \text{Break-even sales})}{\text{Current sales}}$ . Using the data just presented, we compute the margin of safety rate as follows:

$$\begin{aligned}\text{Margin of safety rate} &= \frac{(\text{Current sales} - \text{Break-even sales})}{\text{Current sales}} \\ &= \frac{(\text{USD } 120,000 - \text{USD } 100,000)}{\text{USD } 120,000} \\ &= 16.67 \text{ per cent}\end{aligned}$$

This means that sales volume could drop by 16.67 per cent before the company would incur a loss.

### Cost-volume-profit analysis illustrated

CVP analysis has many applications. This section illustrates several applications using airline data.

The management of a major airline wishes to know how many seats must be sold on Flight 529 to break even. To solve this problem, management must identify and separate costs into fixed and variable categories.

The fixed costs of Flight 529 are the same regardless of the number of seats filled. Fixed costs include the fuel required to fly the plane and crew (with no passengers) to its destination; depreciation on the plane used on the flight; and salaries of required crew members, gate attendants, and maintenance and refueling personnel.

The variable costs vary directly with the number of passengers. Variable costs include snacks and beverages provided to passengers, baggage handling costs, and the cost of the additional fuel required to fly the plane with passengers to its destination. Management would express each variable cost on a per passenger basis.

Assume that after analyzing the various costs and separating them into fixed or variable categories, management finds the fixed costs for Flight 529 are USD 12,000 and variable costs are USD 25 per passenger. Tickets cost USD 125. Thus, the contribution margin ratio is 80 per cent or  $[(\text{USD } 125 - \text{USD } 25)/\text{USD } 125]$ .

We can express the break-even point either in sales dollars or in the number of passengers. The break-even point in sales dollars is:

$$\begin{aligned}\text{BE dollars} &= \frac{\text{Fix costs}}{\text{Contribution margin ratio}} \\ &= \frac{\text{USD } 12,000}{0.80} \\ &= \text{USD } 15,000\end{aligned}$$

We can find the break-even point in number of passengers (units) by dividing fixed costs by the contribution margin per unit:

$$\begin{aligned}\text{BE units} &= \frac{\text{Fix costs}}{\text{Contribution margin per unit (passenger)}} \\ &= \frac{\text{USD } 12,000}{(\text{USD } 125 - \text{USD } 25)} \\ &= 120 \text{ passengers}\end{aligned}$$

To check our answers: 120 passengers X USD 125 ticket price = USD 15,000.

With a simple adjustment in the break-even formulas, CVP analysis can also show the sales volume needed to generate some desired level of net income (ignore taxes). To make this adjustment, management adds the desired net income amount to the fixed costs that must be covered. From this, management can determine the necessary sales volume in dollars or units to provide the desired net income. For example, assume management wishes to earn USD 8,000 of net income on Flight 529.

How many passenger tickets must the airline sell to earn USD 8,000? Remember, the contribution margin per ticket is USD 100. We compute the number of tickets to be sold to earn USD 8,000 on a flight as follows:

$$\begin{aligned}\text{Number of units} &= \frac{\text{Fix costs} + \text{Desired net income}}{\text{Contribution margin per unit}} \\ &= \frac{\text{USD } 12,000 + \text{USD } 8,000}{\text{USD } 100}\end{aligned}$$

## 21. Cost-volume-profit analysis

$$= \frac{\text{USD } 20,000}{\text{USD } 100}$$

$$= 200 \text{ tickets}$$

The airline must sell 200 tickets to earn net income of USD 8,000. To check our answer: (200 tickets X USD 125 sales price per ticket) - (200 tickets X USD 25 variable cost per ticket) - USD 12,000 fixed costs = USD 25,000 - USD 5,000 - USD 12,000 = USD 8,000.

The airline management can also use cost-volume-profit analysis to determine the effect of changing the sales price. To illustrate, assume that Flight 529 normally carries 150 passengers (sales of USD 18,750 and net income of USD 3,000), and the airline decides to increase ticket prices by 5 per cent. If variable and fixed costs remain constant and passenger load does not change, net income increases from USD 3,000 to USD 3,937.50 as follows:

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

$$[\text{USD } 125[1.05] \times 150 \text{ passengers}] - (\text{USD } 25 \times 150 \text{ passengers}) - \text{USD } 12,000 = \text{NI}$$

$$\text{USD } 19,687.50 - \text{USD } 3,750 - \text{USD } 12,000 = \text{NI}$$

$$\text{USD } 3,937.50 = \text{NI}$$

Net income would rise by the entire amount of the price increase (USD 19,687.50 - USD 18,750 = USD 937.50).

Management can use cost-volume-profit analysis to calculate the sales needed to maintain net income when costs change. For example, assume both fixed and variable costs would increase for the airline if the price of fuel rises. Assume that fixed costs increase by USD 4,000 and variable costs increase by USD 6.25 per passenger. Variable costs are now 25 per cent, or (USD 31.25/USD 125), of the sales price. The contribution margin is now USD 93.75, or (USD 125 - USD 31.25), per passenger. The contribution margin ratio is now 75 per cent, or (USD 93.75/USD 125).

To maintain the current net income of USD 3,000, the airline needs to increase sales revenue to USD 25,333:

$$\text{Revenue required} = \frac{\text{Fix costs} + \text{Desired net income}}{\text{Contribution margin ratio}}$$

$$= \frac{\text{USD } 16,000 + \text{USD } 3,000}{0.75}$$

$$= \text{USD } 25,333$$

Management can also use its knowledge of cost-volume-profit relationships to determine whether to increase sales promotion costs in an effort to increase sales volume or to accept an order at a lower-than-usual price. In general, the careful study of cost behavior helps management plan future courses of action.

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### A broader perspective:

#### Major television networks are finding it harder to break even

With increasing competition from cable and satellite television, prerecorded videos, and independent stations, the three major television networks are facing smaller and smaller margins of

safety. Most new shows do not break even. Many do not even cover their variable costs and are dropped during the first season.

As the networks find it more and more difficult to break even on their regular shows, they are expanding into cable, satellite, and pay-per-view television. For example, the National Broadcasting Company (NBC), a major television network owned by General Electric Company, is part owner of a national cable channel and a sports channel. The company has also invested in CNBC, a cable network that specializes in consumer and business issues.

Based on the authors' research.

### Assumptions made in cost-volume-profit analysis

To summarize, the most important assumptions underlying CVP analysis are:

- Selling price, variable cost per unit, and total fixed costs remain constant through the relevant range. This means that a company can sell more or fewer units at the same price and that the company has no change in technical efficiency as volume changes.
- In multi-product situations, the product mix is known in advance.
- Costs can be accurately classified into their fixed and variable portions.

Critics may call these assumptions unrealistic in many situations, but they greatly simplify the analysis.

### Using computer spreadsheets for CVP analysis

Computer spreadsheet packages are well suited for CVP analysis because they enable managers to answer what-if questions. The cost and revenue items in CVP analysis are estimates, not actual results. Since they are used in planning and decision making, it is reasonable to ask whether plans or decisions would change if the estimates changed. The most important issue is whether the information is correct. The output is only as good as the information that goes in.

Consider the following example: The management of Prince Cruises wants to know what the income before taxes would be for a proposed product, a Caribbean cruise. The analyst prepared the following formulas for the spreadsheet:

- Revenue equals ticket price times number of passengers (amounts to be inserted for ticket price and number of passengers).
- Contribution margin equals (amount to be inserted) per cent of revenue.
- Fixed costs equal USD 200,000.
- Income equals revenue minus variable costs minus fixed costs.

Management then inserted various values for ticket price, number of passengers, the per cent of variable cost to revenue, and fixed costs, all per cruise. Exhibit 24 shows the results. Based on these results, management sees what combinations of ticket price, number of passengers, and contribution ratio are required for the cruise to be profitable.

## 21. Cost-volume-profit analysis

We show only a few of the possible combinations in Exhibit 24 to save space. Spreadsheets provide the advantage of a large number of possible combinations with minimal data entry.

Fixed cost	Ticket price	Number of passengers	Per cent contribution margin to revenue	Income
\$200,000	\$3,000	100	70%	\$10,000
200,000	3,000	80	70%	(32,000)
200,000	3,000	100	75%	25,000
200,000	3,000	80	75%	(20,000)
200,000	4,000	70	70%	(4,000)
200,000	4,000	50	70%	(60,000)
200,000	4,000	70	75%	10,000
200,000	4,000	50	75%	(50,000)

Exhibit 24: Spreadsheet analysis of CVP relationships

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### An accounting perspective:

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#### Uses of technology

Cost-volume-profit analysis using a computer spreadsheet is becoming routine. In many business meetings, we find one or more people crunching cost-volume-profit numbers on their notebook or laptop computers.

### Effect of automation on cost-volume-profit analysis

Increasing automation does not affect the fundamental CVP model or the types of analysis we have discussed. However, it does affect the relative size of fixed and variable costs. As companies become more automated, they substitute machinery for labor. Companies that make this substitution often increase fixed costs and decrease variable costs. For example, when banks installed automated teller machines, their labor costs decreased but their fixed costs, including machine depreciation, increased.

When a company substitutes fixed costs for variable costs, the total cost line shifts up as shown in Exhibit 25. At low levels of volume, becoming more automated increases total costs, but at high levels of volume it decreases them. What does this do to the company's break-even point? It depends on where the revenue line crosses the total cost line.

### Illustration 21.9 Effects of Automation

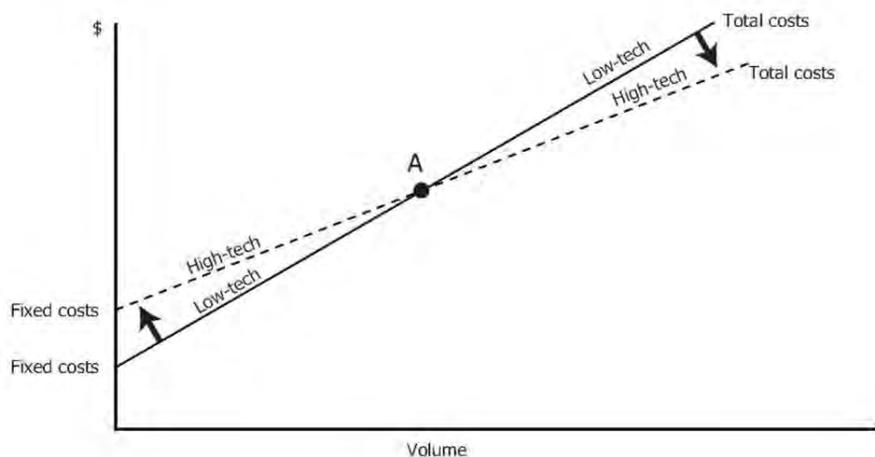


Exhibit 25: Effects of automation

If it crosses at low volumes, to the left of point A in Exhibit 25, then increasing automation increases the company's break-even point. At high volumes, however, if increasing automation lowers total costs, it lowers the company's break-even point.

In this chapter we began studying short-run decisions based on cost-volume-profit analysis. In Chapter 22 we will apply differential analysis to short-term decisions.

#### Understanding the learning objectives

- **Fixed costs.** These costs remain constant in total over some relevant range of output and are often described as time-related costs. Depreciation and insurance are examples.
- **Variable costs.** These costs vary in total directly with changes in the volume of production or sales. Direct materials and sales commissions are examples.
- **Mixed costs.** These costs contain a fixed portion of cost incurred even when the plant is completely idle and a variable portion that increases directly with production volume. Electricity is an example of a mixed cost.
- **Step costs.** These costs remain constant at a certain fixed amount over a short range of output (or sales) but increase to higher amounts at certain points. The cost of supervisors' salaries is an example.
- The scatter diagram shows plots of actual costs incurred for various levels of activity.
- The high-low method uses the highest and lowest points on a scatter diagram to fit a line to the data.
- Cost-volume-profit analysis (sometimes called break-even analysis) can determine what effects any changes in a company's selling prices, costs, and/or volume will have on net income in the short run.
- The break-even point is that level of operations at which a company realizes no income or loss.
- To compute the break-even point in sales dollars:

## 21. Cost-volume-profit analysis

$$\text{BE dollars} = \frac{\text{Fix costs}}{\text{Contribution margin ratio}}$$

Or, to express the break-even point in units:

$$\text{BE units} = \frac{\text{Fix costs}}{\text{Contribution margin per unit}}$$

- To compute the margin of safety:

Margin of safety = Current sales – Break-even sales

- Applications include calculation of the break-even point, calculation of the sales volume needed for a desired net income, calculation of the effect of changing price on net income, and calculation of the sales needed to maintain net income when costs change.
- Selling price, variable cost per unit, and total fixed costs remain constant through the relevant range.
- In multi-product situations, the product mix is known in advance.
- Costs can be accurately classified into their fixed and variable portions.
- Computer spreadsheet packages are well suited for CVP analysis because they enable managers to answer what-if questions.
- As companies become more automated, they substitute machinery for labor, which generally increases fixed costs and decreases variable costs.

### Demonstration problem

**Demonstration problem A** Davis Company has fixed costs of USD 625,000 per year and variable costs of USD 7.50 per unit. Its product sells for USD 12.50 per unit. Full capacity is 200,000 units. The contribution margin is USD 5 per unit (USD 12.50 - USD 7.50).

- Compute the break-even point in (1) sales dollars and (2) units.
- Compute the number of units the company must sell if it wishes to have net income of USD 300,000.

**Demonstration problem B** At the beginning of this chapter, we presented a problem: A campus organization wants to show movies. Recall that the movie rental would be USD 1,000. Rent for an auditorium, salaries to the ticket takers and other personnel, and other fixed costs would be USD 800 for the weekend. The organization would sell tickets for USD 4 per person. In addition, profits from the sale of soft drinks, popcorn, and candy are estimated to be USD 1 per ticket holder. How many people have to buy tickets for the organization to break even?

### Solution to demonstration problem

#### Solution to demonstration problem A

- (1) The contribution margin ratio is 0.40.

$$\text{BE dollars} = \frac{\text{Fix costs}}{\text{Contribution margin ratio}}$$

$$\text{BE dollars} = \frac{\text{USD } 625,000}{0.40}$$

= USD 1,562,500

$$(2) \text{ BE units} = \frac{\text{Fix costs}}{\text{Contribution margin per unit}}$$

$$\text{BE units} = \frac{\text{USD } 625,000}{\text{USD } 5}$$

= 125,000 units

$$b. \text{ Number of units} = \frac{\text{Fix cost} + \text{Desired net income}}{\text{Contribution margin per unit}}$$

$$= \frac{\text{USD } 625,000 + \text{USD } 300,000}{\text{USD } 5}$$

$$= \frac{\text{USD } 925,000}{\text{USD } 5}$$

= 185,000 units

### Solution to demonstration problem B

$$\text{Number of ticket buyers so they break even} = \frac{\text{USD } 1,000 + \text{USD } 800}{\text{USD } 4 + \text{USD } 1}$$

$$= \frac{\text{USD } 1,800}{\text{USD } 5}$$

= 360 ticket buyers

### Key terms\*

**Break-even point** That level of operations at which revenues for a period are equal to the costs assigned to that period so there is no net income or loss.

**Contribution margin** The amount by which revenue exceeds the variable costs of producing that revenue. The contribution margin per unit is the selling price minus the variable cost per unit.

**Contribution margin ratio** Contribution margin per unit divided by selling price per unit, or total contribution margin divided by total revenues.

**Cost-volume-profit (CVP) analysis** An analysis of the effect that any changes in a company's selling prices, costs, and/or volume will have on income (profits) in the short run. Also called break-even analysis.

**Cost-volume-profit (CVP) chart** A graph that shows the relationships among sales, volume, costs, and net income or loss.

**Fixed costs** Costs that remain constant (in total) over some relevant range of output.

**High-low method** A method used in dividing mixed costs into their fixed and variable portions. The high plot and low plot of actual costs are used to draw a line representing a total mixed cost.

**Margin of safety** Amount by which sales can decrease before a loss is incurred.

**Margin of safety rate** Margin of safety expressed as a percentage, which equals (Current sales – Break-even sales)/Current sales.

**Mixed cost** Contains a fixed portion of cost incurred even when the plant is completely idle and a variable portion that increases directly with production volume.

**Product mix** The proportion of the company's total sales attributable to each type of product sold.

**Profit equation** The equation is Net income = Revenue - Total variable costs - Fixed costs.

**Relevant range** The range of production or sales volume over which the assumptions about cost behavior are valid.

## 21. Cost-volume-profit analysis

**Scatter diagram** A diagram that shows plots of actual costs incurred for various levels of activity; it is used in dividing mixed costs into their fixed and variable portions.

**Short run** The time during which a company's management cannot change the effects of certain past decisions; often determined to be one year or less. In the short run, many costs are assumed to be fixed and unchangeable.

**Step cost** A cost that remains constant at a certain fixed amount over a range of output (or sales) but then keeps increasing to a higher amount at certain points.

**Variable costs** Costs that vary (in total) directly with changes in the volume of production or sales.

\*Some terms listed in earlier chapters are repeated here for your convenience.

### Self-test

#### True-false

Indicate whether each of the following statements is true or false.

The scatter diagram method is less precise than the high-low method for evaluating costs.

A break-even point is expressed only in dollars of sales revenues.

Total contribution margin indicates the amount of money remaining after variable and fixed costs are covered.

The margin of safety is calculated using the following formula:

Margin of safety = Break-even sales - Current sales

Dollars of sales are used when computing the break-even point for a multi-product company.

#### Multiple-choice

Select the best answer for each of the following questions.

Under which of the following cost behavior patterns would electricity be categorized?

- a. Variable cost.
- b. Fixed cost.
- c. Mixed cost.
- d. Step cost.

Which of the following are characteristics of step costs?

- a. A fixed component.
- b. Costs increase in steps as production volume increases.
- c. Can remain constant over some relevant range of output.
- d. All of the above.

Using the following data, calculate the sales revenue needed to break even:

Selling price per unit USD 10

Fixed costs 20,000

Variable cost per unit 6

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- a. USD 40,000.
- b. USD 33,333.
- c. USD 50,000.
- d. USD 60,000.

Using the following data, calculate the contribution margin:

Selling price USD 20

Fixed costs 4

Variable cost 6

- a. USD 14.
- b. USD 10.
- c. USD 16.
- d. USD 18.

Using the following data, calculate the break-even point in units:

Selling price per unit USD 20

Fixed costs 28,000

Variable cost per unit 6

- a. 1,400 units.
- b. 2,800 units.
- c. 2,275 units.
- d. 2,000 units.

Which of the following describe(s) the underlying assumptions of cost-volume-profit analysis?

- a. Selling price, variable cost per unit, and total fixed costs remain constant through the relevant range.
- b. In multi-product situations, the product mix is known in advance.
- c. Costs can be accurately classified into their fixed and variable portions.
- d. All of the above.

Now turn to “Answers to self-test” at the end of the book to check your answers.

## Questions

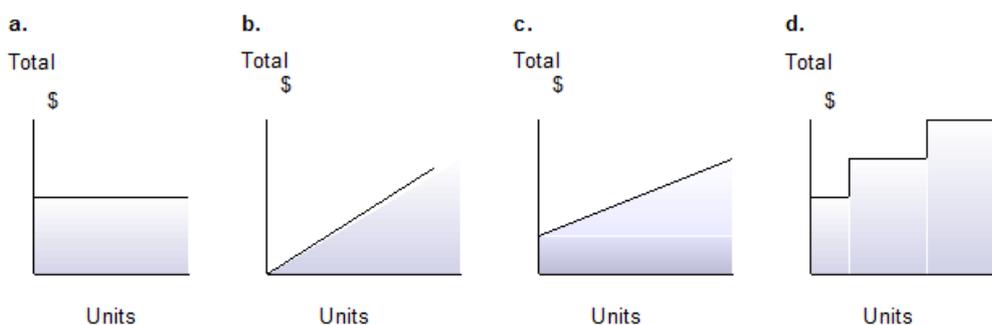
- Name and describe four cost behavior patterns.
- Describe two methods of determining the fixed and variable components of mixed costs.
- What is meant by the term break-even point?

## 21. Cost-volume-profit analysis

- What are two ways in which the break-even point can be expressed?
- What is the relevant range?
- What is the formula for calculating the break-even point in sales revenue?
- What formula is used to solve for the break-even point in units?
- How can the break-even formula be altered to calculate the number of units that must be sold to achieve a desired level of income?
- Why might a business wish to lower its break-even point? How would it go about lowering the break-even point?
- What effect would you expect the mechanization and automation of production processes to have on the break-even point?
- **Real world question** Assume your college is considering hiring a lecturer to teach a special class in communication skills. Identify at least two costs that college administrators might consider in deciding whether to hire the lecturer and add the class.
- **Real world question** Two enterprising students are considering renting space and opening a class video recording service. They would hire camera operators to record large introductory classes. The students taking the classes would be charged a fee to rent and view the video on their laptops or smart phones. Identify as many costs of this business as you can and indicate which would be variable and which would be fixed.

### Exercises

**Exercise A** Name and match the types of cost behavior with the appropriate diagram below:



**Exercise B** Research Inc., performs laboratory tests. Use the high-low method to determine the fixed and variable components of a mixed cost, given the following observations:

Volume (number of tests)	Total cost
4,800	\$6,000
19,200	9,600

**Exercise C** Compute the break-even point in sales dollars if fixed costs are USD 200,000 and the total contribution margin is 20 per cent of revenue.

**Exercise D** Barney Company makes and sells stuffed animals. One product, Michael Bears, sells for USD 28 per bear. Michael Bears have fixed costs of USD 100,000 per month and a variable cost of USD 12 per bear. How many Michael Bears must be produced and sold each month to break even?

**Exercise E** Peter Garcia Meza is considering buying a company if it will break even or earn net income on revenues of USD 80,000 per month. The company that Peter is considering sells each unit it produces for USD 5. Use the following cost data to compute the variable cost per unit and the fixed cost for the period. Calculate the break-even point in sales dollars. Should Peter buy this company?

Volume (units)	Cost
8,000	\$70,000
68,000	190,000

**Exercise F** Never Late Delivery currently delivers packages for USD 9 each. The variable cost is USD 3 per package, and fixed costs are USD 60,000 per month. Compute the break-even point in both sales dollars and units under each of the following independent assumptions. Comment on why the break-even points are different.

- The costs and selling price are as just given.
- Fixed costs are increased to USD 75,000.
- Selling price is increased by 10 per cent. (Fixed costs are USD 60,000.)
- Variable cost is increased to USD 4.50 per unit. (Fixed costs are USD 60,000 and selling price is USD 9.)

**Exercise G** Best Eastern Motel is a regional motel chain. Its rooms rent for USD 100 per night, on average. The variable cost is USD 40 a room per night. Fixed costs are USD 5,000,000 per year. The company currently rents 200,000 units per year, with each unit defined as one room for one night. Should this company undertake an advertising campaign resulting in a USD 500,000 increase in fixed costs per year, no change in variable cost per unit, and a 10 per cent increase in revenue (resulting from an increase in the number of rooms rented)? What is the margin of safety before and after the campaign?

**Exercise H** Fall-For-Fun Company sells three products. Last year's sales were USD 600,000 for parachutes, USD 800,000 for hang gliders, and USD 200,000 for bungee jumping harnesses. Variable costs were: parachutes, USD 400,000; hang gliders, USD 700,000; and bungee jumping harnesses, USD 100,000. Fixed costs were USD 240,000. Find (a) the break-even point in sales dollars and (b) the margin of safety.

**Exercise I** Early Horizons Day Care Center has fixed costs of USD 300,000 per year and variable costs of USD 10 per child per day. If it charges USD 25 a child per day, what will be its break-even point expressed in dollars of revenue? How much revenue would be required for Early Horizons Day Care to earn USD 100,000 net income per year?

### Problems

**Problem A** Assume the local franchise of Togorio Sandwich Company assigns you the task of estimating total maintenance cost on its delivery vehicles. This cost is a mixed cost. You receive the following data from past months:

Month	Units	Costs
March	8,000	\$14,000
April	10,000	14,960
May	9,000	15,200
June	11,000	15,920

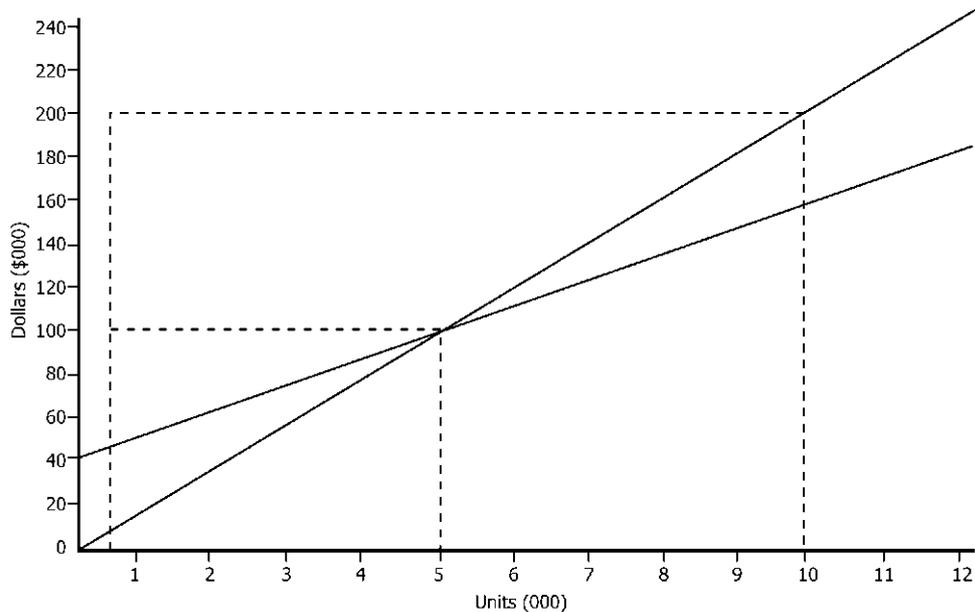
## 21. Cost-volume-profit analysis

July	10,000	15,920
August	13,000	16,880
September	14,000	18,080
October	18,000	19,280
November	20,000	21,200

a. Using the high-low method, determine the total amount of fixed costs and the amount of variable cost per unit. Draw the cost line.

b. Prepare a scatter diagram, plot the actual costs, and visually fit a linear cost line to the points. Estimate the amount of total fixed costs and the amount of variable cost per unit.

### Problem B



a. Using the preceding graph, label the relevant range, total costs, fixed costs, break-even point, and profit and loss areas.

b. At 8,000 units, what are the variable costs, fixed costs, sales, and contribution margin amounts in dollars?

c. At 8,000 units, is there net income or loss? How much?

**Problem C** The management of Bootleg Company wants to know the break-even point for its new line hiking boots under each of the following independent assumptions. The selling price is USD 50 pair of boots unless otherwise stated. (Each pair of boots is one unit.)

a. Fixed costs are USD 300,000; variable cost is USD 30 per unit.

b. Fixed costs are USD 300,000; variable cost is USD 20 per unit.

c. Fixed costs are USD 250,000; variable cost is USD 20 per unit.

d. Fixed costs are USD 250,000; selling price is USD 40; and variable cost is USD 30 per unit.

Compute the break-even point in units and sales dollars for each of the four independent case.

**Problem D** Refer to the previous problem. Bootleg Company's sales are USD 1,100,000. Determine the margin (safety in dollars for cases (a) through (d)).

**Problem E** Using the data in the Bootleg Company problem (a through d), determine the level of sales dollars required achieve a net income of USD 125,000.

**Problem F** Bikes Unlimited, Inc., sells three types of bicycles. It has fixed costs of USD 258,000 per month. The sales and variable costs of these products for April follow:

	<b>Bikes</b>		
	<b>Racing</b>	<b>Mountain</b>	<b>Touring</b>
Sales	\$1,00,000	\$1,500,000	\$2,500,000
Variable costs	700,000	900,000	1,250,000

Compute the break-even point in sales dollars.

**Problem G** a. Assume that fixed costs of Celtics Company are USD 180,000 per year, variable cost is USD 12 per unit, and selling price is USD 30 per unit. Determine the break-even point in sales dollars.

b. Hawks Corporation breaks even when its sales amount to USD 89,600,000. In 2010, its sales were USD 14,400,000, and its variable costs amounted to USD 5,760,000. Determine the amount of its fixed costs.

c. The sales of Niners Corporation last year amounted to USD 20,000,000, its variable costs were USD 6,000,000, and its fixed costs were USD 4,000,000. At what level of sales dollars would the Niners Corporation break even?

d. What would have been the net income of the Niners Corporation in part (c), if sales volume had been 10 per cent higher but selling prices had remained unchanged?

e. What would have been the net income of the Niners Corporation in part (c), if variable costs had been 10 per cent lower?

f. What would have been the net income of the Niners Corporation in part (c), if fixed costs had been 10 per cent lower?

g. Determine the break-even point in sales dollars for the Niners Corporation on the basis of the data given in (e) and then in (f).

Answer each of the preceding questions.

**Problem H** After graduating from college, M. J. Orth started a company that produced cookbooks. After three years, Orth decided to analyze how well the company was doing. He discovered the company has fixed costs of USD 1,200,000 per year, variable cost of USD 14.40 per cookbook (on average), and a selling price of USD 26.90 per cookbook (on average).

How many units (that is, cookbooks) must be sold to break even? How many units will the company have to sell to earn USD 48,000?

**Problem I** The operating results for two companies follow:

	<b>Sierra</b>	<b>Olympias</b>
Sales (20,000) units	\$1,920,000	\$1,920,000
Variable costs	480,000	1,056,000
Contribution margin	1,440,000	864,000

## 21. Cost-volume-profit analysis

Fixed costs	960,000	384,00
Net income	480,000	480,000

- Prepare a cost-volume-profit chart for Sierra Company, indicating the break-even point, the contribution margin, and the areas of income and losses.
- Compute the break-even point of both companies in sales dollars and units.
- Assume that without changes in selling price, the sales of each company decline by 10 per cent. Prepare income statements similar to the preceding statements for both companies.

**Problem J** Soundoff, Inc., a leading manufacturer of electronic equipment, decided to analyze the profitability of its new portable compact disc (CD) players. On the CD player line, the company incurred USD 2,520,000 of fixed costs per month while selling 20,000 units at USD 600 each. Variable cost was USD 240 per unit.

Recently, a new machine used in the production of CD players has become available; it is more efficient than the machine currently being used. The new machine would reduce the company's variable costs by 20 per cent, and leasing it would increase fixed costs by USD 96,000 per year.

- Compute the break-even point in units assuming use of the old machine.
- Compute the break-even point in units assuming use of the new machine.
- Assuming that total sales remain at USD 12,000,000 and that the new machine is leased, compute the expected net income.
- Should the new machine be leased? Why?

**Problem K** Surething CD Company reports sales of USD 720,000, variable costs of USD 432,000, and fixed costs of USD 108,000. If the company spends USD 72,000 on a sales promotion campaign, it estimates that sales will be increased by USD 270,000.

Determine whether the sales promotion campaign should be undertaken. Provide calculations.

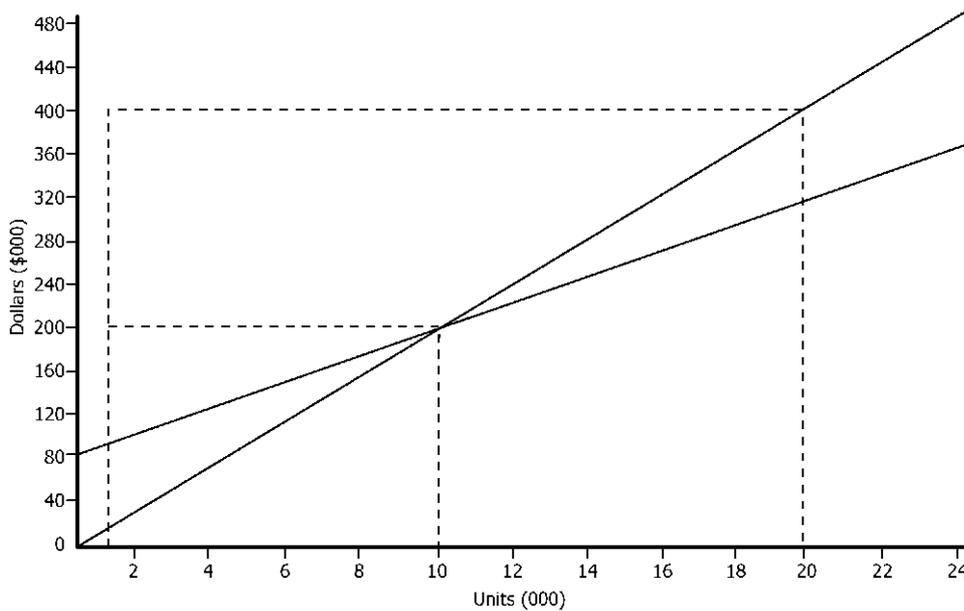
### Alternate problems

**Alternate problem A** Hear Right Company has identified certain variable and fixed costs in its production of hearing aids. Management wants you to divide one of its mixed costs into its fixed and variable portions. Here are the data for this cost:

Month	Units	Costs
January	20,800	\$57,600
February	20,000	54,000
March	22,000	58,500
April	25,600	57,600
May	28,400	58,500
June	30,000	62,100
July	32,800	63,900
August	35,600	68,400
September	37,600	72,000
October	40,000	77,400

- Using the high-low method, determine the total amount of fixed costs and the amount of variable cost per unit. Draw the cost line.
- Prepare a scatter diagram, plot the actual costs, and visually fit a linear cost line to the points. Estimate the amount of total fixed costs and the variable cost per unit.

**Alternate problem B**



- Using the preceding graph, label the relevant range, total costs, fixed costs, break-even point, and profit and loss areas.
- At 18,000 units, what would sales revenue, total costs, fixed and variable costs be?
- At 18,000 units, would there be a profit or loss? How much?

**Alternate problem C** Jefferson Company has a plant capacity of 100,000 units, at which level variable costs are USD 720,000. Fixed costs are expected to be USD 432,000. Each unit of product sells for USD 12.

- Determine the company's break-even point in sales dollars and units.
- At what level of sales dollars would the company earn net income of USD 144,000?
- If the selling price were raised to USD 14.40 per unit, at what level of sales dollars would the company earn USD 144,000?

**Alternate problem D** a. Determine the break-even point in sales dollars and units for Cowboys Company that has fixed costs of USD 63,000, variable cost of USD 24.50 per unit, and a selling price of USD 35.00 per unit.

- Wildcats Company breaks even when sales are USD 280,000. In March, sales were USD 670,000, and variable costs were USD 536,000. Compute the amount of fixed costs.
- Hoosiers Company had sales in June of USD 84,000; variable costs of USD 46,200; and fixed costs of USD 50,400. At what level of sales, in dollars, would the company break even?
- What would the break-even point in sales dollars have been in (c) if variable costs had been 10 per cent higher?
- What would the break-even point in sales dollars have been in (c) if fixed costs had been 10 per cent higher?

## 21. Cost-volume-profit analysis

f. Compute the break-even point in sales dollars for Hoosiers Company in (c) under the assumptions of (d) and (e) together.

Answer each of the preceding questions.

**Alternate problem E** See Right Company makes contact lenses. The company has a plant capacity of 200,000 units. Variable costs are USD 4,000,000 at 100 per cent capacity. Fixed costs are USD 2,000,000 per year, but this is true only between 50,000 and 200,000 units.

a. Prepare a cost-volume-profit chart for See Right Company assuming it sells its product for USD 40 each. Indicate on the chart the relevant range, break-even point, and the areas of net income and losses.

b. Compute the break-even point in units.

c. How many units would have to be sold to earn USD 200,000 per year?

**Alternate problem F** Mr Feelds Cookies has fixed costs of USD 360,000 per year. It sells three types of cookies. The cost and revenue data for these products follow:

	<b>Cookies</b>		
	<b>Cream cake</b>	<b>Goo fill</b>	<b>Sweet tooth</b>
Sales	\$64,000	\$95,000	\$131,000
Variable costs	38,400	55,100	66,000

Compute the break-even point in sales dollars.

### Beyond the numbers—Critical thinking

**Business decision case A** Quality Furniture Company is operating at almost 100 per cent of capacity. The company expects sales to increase by 25 per cent in 2011. To satisfy the demand for its product, the company is considering two alternatives: The first alternative would increase fixed costs by 15 per cent but not affect variable costs. The second alternative would not affect fixed costs but increase variable costs to 60 per cent of the selling price of the company's product.

This is Quality Furniture Company's condensed income statement for 2010:

Sales		\$3,600,000
Costs:		
Variable	\$1,620,000	
Fixed	330,000	1,950,000
Income before taxes		\$1,650,000

a. Determine the break-even point in sales dollars for 2011 under each of the alternatives.

b. Determine projected income for 2011 under each of the alternatives.

c. Which alternative would you recommend? Why?

**Business decision case B** When the Weidkamp Company's plant is completely idle, fixed costs amount to USD 720,000. When the plant operates at levels of 50 per cent of capacity or less, its fixed costs are USD 840,000; at levels more than 50 per cent of capacity, its fixed costs are USD 1,200,000. The company's variable costs at full capacity (100,000 units) amount to USD 1,800,000.

a. Assuming that the company's product sells for USD 60 per unit, what is the company's break-even point in sales dollars?

b. Using only the data given, at what level of sales would it be more economical to close the factory than to operate it? In other words, at what level would operating losses approximate the losses incurred if the factory closed down completely?

c. Assume that Weidkamp Company is operating at 50 per cent of its capacity and decides to reduce the selling price from USD 60 per unit to USD 36 per unit to increase sales. At what percentage of capacity must the company operate to break even at the reduced sales price?

**Business decision case C** Monroe Company has recently been awarded a contract to sell 25,000 units of its product to the federal government. Monroe manufactures the components of the product rather than purchasing them. When the news of the contract was released to the public, President Mary Monroe, received a call from the president of the McLean Corporation, Carl Cahn. Cahn offered to sell Monroe 25,000 units of a needed component, Part J, for USD 15.00 each. After receiving the offer, Monroe calls you into her office and asks you to recommend whether to accept or reject Cahn's offer.

You go to the company's records and obtain the following information concerning the production of Part J.

	<b>Costs at current production level (200,000 units)</b>
Direct labor	\$1,248,000
Direct materials	576,000
Manufacturing overhead	600,000
Total cost	\$2,424,000

You calculate the unit cost of Part J to be USD 12.12 or (USD 2,424,000/200,000). But you suspect that this unit cost may not hold true at all production levels. To find out, you consult the production manager. She tells you that to meet the increased production needs, equipment would have to be rented and the production workers would work some overtime. She estimates the machine rental to be USD 60,000 and the total overtime premiums to be USD 108,000. She provides you with the following information:

	<b>Costs at current production level (225,000 units)</b>
Direct labor	\$1,404,000
Direct materials	648,000
Manufacturing overhead (including equipment rental and overtime premiums)	828,000
Total cost	\$2,880,000

The production manager advises you to reject Cahn's offer, since the unit cost of Part J would be only USD 12.80 or (USD 2,880,000/225,000 units) with the additional costs of equipment rental and overtime premiums. This amount still is less than the USD 15.00 that Cahn would charge. Undecided, you return to your office to consider the matter further.

a. Using the high-low method, compute the variable cost portion of manufacturing overhead. (Remember that the costs of equipment rental and overtime premiums are included in manufacturing overhead. Subtract these amounts before performing the calculation).

b. Compute the total costs to manufacture the additional units of Part J. (Note: include overtime premiums as a part of direct labor.)

c. Compute the unit cost to manufacture the additional units of Part J.

## 21. Cost-volume-profit analysis

d. Write a report recommending that Monroe accept or reject Cahn's offer.

**Business decision case D** Refer to the "A broader perspective: Major television networks are finding it harder to break even" discussion of cost-volume-profit analysis for television networks. Write a memo to your instructor describing how the networks can reduce their break-even points.

**Group project E** In teams of two or three students, develop a cost-volume-profit equation for a new business that you might start. Examples of such businesses are a portable espresso bar, a pizza stand, a campus movie theater, a package delivery service, a campus-to-airport limousine service, and a T-shirt printing business.

Your equation should be in the form:  $\text{Profits} = (\text{Price per unit} \times \text{Volume}) - (\text{Variable cost per unit} \times \text{Volume}) - \text{Fixed costs per period}$ . Pick a period of time, say one month, and project the unit price, volume, unit variable cost, and fixed costs for the period. From this information, you will be able to estimate the profits—or losses—for the period. Select one spokesperson for your team to tell the class about your proposed business and its profits or losses. Good luck, and have fun.

**Group project F** Refer to "A broader perspective: Even colleges use CVP" discussion of how cost-volume-profit analysis is used by colleges. In teams of two or three students, write a memo to your instructor defining step costs and explain why the step costs identified in the case are classified as such. Also include in your memo how the school might lower its break-even point.

**Group project G** In teams of two or three students, address the following questions:

- Why would a company consider increasing automation and decreasing the use of labor if the result would be an increase in the break-even point?
- Would an increase in automation increase fixed costs over the short-run, long-run, or both?

Write a memo to your instructor that addresses both questions. Be sure to explain your answers.

### Using the Internet—A view of the real world

Visit the website for Intel Corporation, a high technology manufacturing company.

<http://www.intel.com>

Go to the company's most recent financial statements and review the consolidated statement of income. What additional information, if any, would you need to perform cost-volume-profit analysis? Why is this information excluded from Intel's income statement?

Visit the website for Wal-Mart Corporation, a retail company.

<http://www.walmart.com>

Go to the company's most recent financial statements and review the statement of income. What additional information, if any, would you need to perform cost-volume-profit analysis? Why is this information excluded from Wal-Mart Corporation's income statement?

### Answers to self-test

#### True-false

**False.** The high-low method is less precise than the scatter diagram because it requires only two data points in the computation.

**False.** The break-even point can also be expressed in units produced or sold.

**False.** Total contribution margin is the amount by which revenue exceeds variable costs of producing that revenue.

**False.** Margin of safety = Current sales - Break-even sales.

**True.** Dollars of sales are used as the measure of volume when a company has many different products.

### Multiple-choice

**c.** Electricity is a mixed cost.

**d.** Step costs have all of these characteristics—a fixed component, costs increase, and constancy over a relevant range for a step.

$$\mathbf{c.} \quad \text{BE dollars} = \frac{\text{Fix costs}}{\text{Contribution margin ratio}}$$

$$\text{Contribution margin ratio} = \frac{(\text{USD } 10 - \text{USD } 6)}{\text{USD } 10} = 0.40$$

$$\text{BE dollars} = \frac{\text{USD } 20,000}{0.40} = \text{USD } 50,000$$

**a.** Contribution margin = Selling price – Variable costs

$$= \text{USD } 20 - \text{USD } 6 = \text{USD } 14$$

$$\mathbf{d.} \quad \text{BE units} = \frac{\text{Fix costs}}{\text{Contribution margin per unit}}$$

$$\text{BE units} = \frac{\text{USD } 28,000}{\text{USD } 14 \text{ per unit}}$$

$$= 2,000$$

**d.** All of these are assumptions—prices and costs remain constant through the relevant range, product mix is known, and costs can be accurately classified into fixed and variable components.