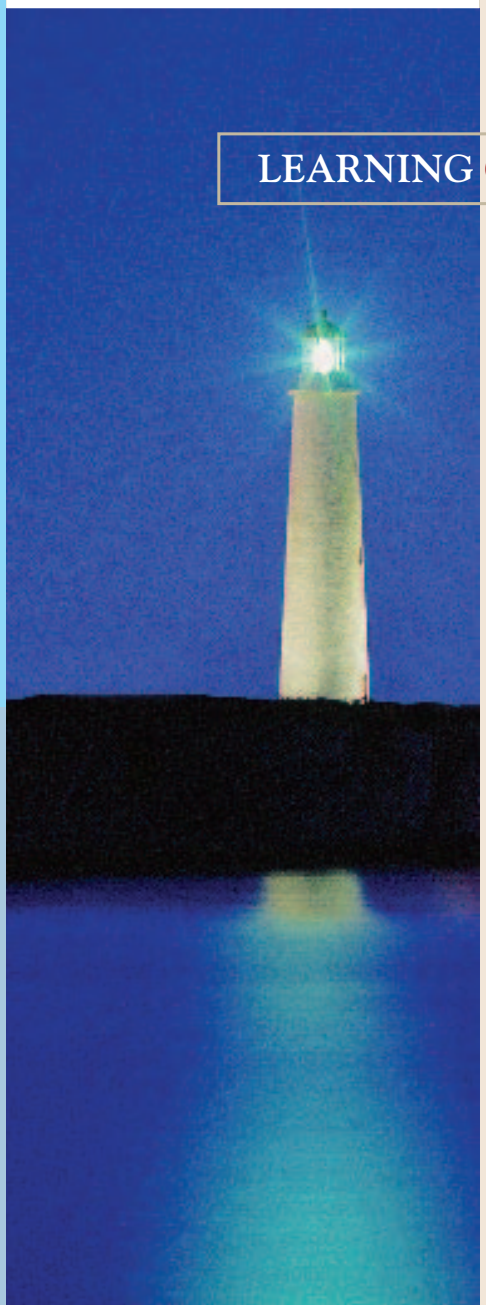
Chapter 5

Cost Behavior: Analysis and Use



LEARNING OBJECTIVES

After studying Chapter 5, you should be able to:

LO1 Understand how fixed and variable costs behave and how to use them to predict costs.

LO2 Use a scattergraph plot to diagnose cost behavior.

LO3 Analyze a mixed cost using the high-low method.

LO4 Prepare an income statement using the contribution format.

LO5 (Appendix 5A) Analyze a mixed cost using the least-squares regression method.

A Costly Mistake

BUSINESS FOCUS

After spending countless hours tracking down the hardware and fixtures he needed to restore his Queen Anne-style Victorian house, Stephen Gordon recognized an opportunity. He opened Restoration Hardware, Inc., a specialty store carrying antique hardware and fixtures. The company's products are described by some as nostalgic, old-fashioned, and obscure. Customers can shop at one of the many Restoration Hardware stores, by catalog, or online at the company's website www.restorationhardware.com.

1998 was a year of phenomenal growth and change for Restoration Hardware. Twenty-four new stores were opened, increasing the total number in the chain to 65. The company's newly launched catalog business was an instant success. Net sales approached $200 million, an increase of almost 114% from the prior year. Gordon, chairman and CEO, took the company public.

The success enjoyed by the company in 1998 did not recur in 1999. Gordon believes his biggest mistake was a failure to consider cost behavior when making decisions to promote the company's products. The most popular furniture items in the store were discounted during the first quarter to encourage customer interest. The company spent $1 million to advertise this big sale, which was far more "successful" than Gordon had imagined. Sales for the first quarter increased by 84% to $60 million. However, much of the increase arose from sales of discounted goods. As a result, margins (that is, differences between sale prices and the cost of the goods that were sold) were lower than usual. Further, because the items placed on sale were larger and heavier than average, the costs to move them from the distribution centers to the stores were considerably higher. The company ended up reporting a loss of $2.7 million for the quarter. ■

Sources: Restoration Hardware website July 2000; Stephen Gordon, "My Biggest Mistake," *Inc.*, September 1999, p. 103; Heather Chaplin, "Past? Perfect," *American Demographics*, May 1999, pp. 68–69.

In Chapter 2, we stated that costs can be classified by behavior. Cost behavior refers to how a cost will change as the level of activity changes. Managers who understand how costs behave can predict how costs will change under various alternatives. Conversely, managers who attempt to make decisions without a thorough understanding of cost behavior patterns can create disastrous consequences. For example, cutting back production of a particular product line might result in far less cost savings than managers had assumed if they confused fixed costs with variable costs—leading to a decline in profits. To avoid such problems, managers must be able to accurately predict what costs will be at various activity levels.

This chapter briefly reviews the definitions of variable and fixed costs and then discusses the behavior of these costs in greater depth than was done in Chapter 2. The chapter also introduces the concept of a mixed cost, which is a cost that has variable and fixed cost elements. The chapter concludes by introducing a new income statement format—called the *contribution format*—in which costs are organized by behavior rather than by the traditional functions of production, sales, and administration.

Types of Cost Behavior Patterns

5–1

In Chapter 2 we mentioned only variable and fixed costs. In this chapter we will examine a third cost behavior pattern, known as a *mixed* or *semivariable* cost. All three cost behavior patterns—variable, fixed, and mixed—are found in most organizations. The relative proportion of each type of cost in an organization is known as its **cost structure.** For example, an organization might have many fixed costs but few variable or mixed costs. Alternatively, it might have many variable costs but few fixed or mixed costs. In this chapter, we will concentrate on gaining a fuller understanding of the behavior of each type of cost. In the next chapter, we will explore how cost structure impacts decisions.

IN BUSINESS

COST STRUCTURE: A MANAGEMENT CHOICE

Some managers are thriftier than others. Kenneth Iverson built Nucor Steel into the most successful U.S. steel company of recent years by developing a whole new approach to steel-making using cost-efficient minimills. Iverson ran his company with few layers of management and a commitment to employees that everyone would be treated alike. Workers were "dissuaded from joining a union by high wages and a series of No's—no management dining rooms, no company yachts, no company planes, no first-class travel for executives, and no support staff to pamper the upper echelons." Iverson ran the largest steel company in the U.S. with only 20 people in his headquarters. "By responding to market signals, focusing on a single major product line, and treating his employees with respect and compassion, Mr. Iverson contributed immensely to the industrial rebirth in this country."

Source: Donald F. Barnett and Robert W. Crandall, "Remembering a Man of Steel," *The Wall Street Journal*, April 23, 2002, p. B4.

LEARNING OBJECTIVE 1
Understand how fixed and variable costs behave and how to use them to predict costs.

Variable Costs

We explained in Chapter 2 that a variable cost is a cost whose total dollar amount varies in direct proportion to changes in the activity level. If the activity level doubles, the total variable cost also doubles. If the activity level increases by only 10%, then the total variable cost increases by 10% as well.

IN BUSINESS

SELLING ONLINE

By making investments in technology, cutting edge companies have created radically different cost structures from traditional companies. John Labbett, the CFO of Onsale, an Internet auctioneer of discontinued computers, was previously employed at House of Fabrics, a traditional retailer. The two companies have roughly the same total revenues of about $250 million. However, House of Fabrics, with 5,500 employees, has a revenue per employee of about $90,000. At Onsale, with only 200 employees, the figure is $1.18 million per employee. Additionally, Internet companies like Onsale are often able to grow at very little cost. If demand grows, an Internet company may not have to do much more than just add another computer server. If demand grows at a traditional retailer, the company may have to invest in a new building and additional inventory and may have to hire additional employees.

Source: George Donnelly, "New @ttitude," *CFO,* June 1999, pp. 42–54.

We also found in Chapter 2 that a variable cost remains constant if expressed on a *per unit* basis. To provide an example, consider Nooksack Expeditions, a small company that provides daylong whitewater rafting excursions on rivers in the North Cascade Mountains. The company provides all of the necessary equipment and experienced guides, and it serves gourmet meals to its guests. The meals are purchased from an exclusive caterer for $30 a person for a daylong excursion. If we look at the cost of the meals on a *per person* basis, it remains constant at $30. This $30 cost per person will not change, regardless of how many people participate in a daylong excursion. The behavior of this variable cost, on both a per unit and a total basis, is tabulated as follows:

Number of Guests	Cost of Meals per Guest	Total Cost of Meals
250	$30	$7,500
500	$30	$15,000
750	$30	$22,500
1,000	$30	$30,000

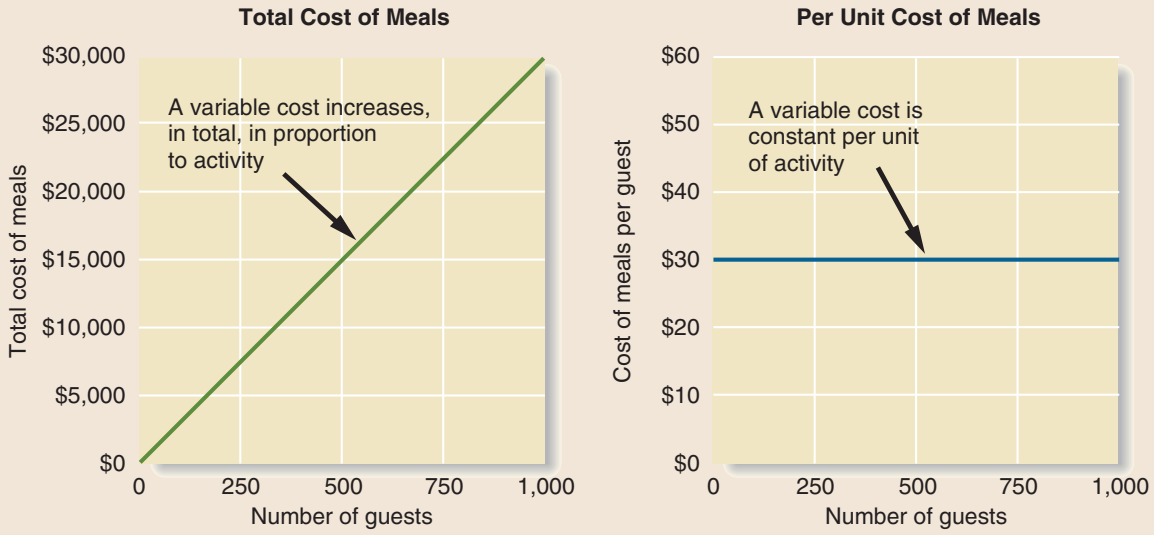
The idea that a variable cost is constant per unit but varies in total with the activity level is crucial to understanding cost behavior patterns. We shall rely on this concept repeatedly in this chapter and in chapters ahead.

Exhibit 5–1 illustrates variable cost behavior. Note that the graph of the total cost of the meals slants upward to the right. This is because the total cost of the meals is directly proportional to the number of guests. In contrast, the graph of the per unit cost of meals is flat because the cost of the meals per guest is constant at $30.

The Activity Base For a cost to be variable, it must be variable *with respect to something*. That "something" is its *activity base*. An **activity base** is a measure of whatever causes the incurrence of variable cost. In Chapter 3, we mentioned that an activity base is sometimes referred to as a *cost driver.* Some of the most common activity bases are direct labor-hours, machine-hours, units produced, and units sold. Other examples of activity bases (cost drivers) include the number of miles driven by salespersons, the number of pounds of laundry cleaned by a hotel, the number of calls handled by technical support staff at a software company, and the number of beds occupied in a hospital.

To plan and control variable costs, a manager must be well acquainted with the organization's various activity bases. People sometimes get the notion that if a cost doesn't vary with production or with sales, then it is not a variable cost. This is not correct. As suggested by the range of bases listed above, costs are caused by many different activities within an organization. Whether a cost is variable or fixed depends on whether it is caused by the activity under consideration. For example, if a manager is analyzing the cost of service calls under a product warranty, the relevant activity measure will be the number of

EXHIBIT 5–1
Variable Cost Behavior



service calls made. Those costs that vary in total with the number of service calls made are the variable costs of making service calls.

Nevertheless, unless stated otherwise, you can assume that the activity base under consideration is the total volume of goods and services provided by the organization. So, for example, if we ask whether direct materials at Ford is a variable cost, the answer is yes, since the cost of direct materials is variable with respect to Ford's total volume of output. We will specify the activity base only when it is something other than total output.

IN BUSINESS

COPING WITH THE FALLOUT FROM SEPTEMBER 11

Costs can change for reasons that have nothing to do with changes in volume. Filterfresh is a company that services coffee machines located in commercial offices—providing milk, sugar, cups, and coffee. The company's operations were profoundly affected by the security measures many companies initiated after the terrorist attacks on the World Trade Center and the Pentagon on September 11, 2001. Heightened security at customer locations means that Filterfresh's 250 deliverymen can no longer casually walk through a customer's lobby with a load of supplies. Now a guard typically checks the deliveryman's identification and paperwork at the loading dock and may search the van before permitting the deliveryman access to the customer's building. These delays have added an average of about an hour per day to each route, which means that Filterfresh needs 24 more delivery people to do the same work it did prior to September 11. That's a 10% increase in cost without any increase in the amount of coffee sold.

Source: Anna Bernasek, "The Friction Economy," *Fortune*, February 18, 2002, pp. 104–112.

Extent of Variable Costs The number and type of variable costs in an organization will depend in large part on the organization's structure and purpose. A public utility like Florida Power and Light, with large investments in equipment, will tend to have few variable costs. Most of the costs are associated with its plant, and these costs tend to be insensitive to changes in levels of service provided. A manufacturing company like Black

EXHIBIT 5–2
Examples of Variable Costs

Type of Organization	Costs that Are Normally Variable with Respect to Volume of Output
Merchandising company	Cost of goods (merchandise) sold
Manufacturing company	Manufacturing costs: Direct materials Direct labor* Variable portion of manufacturing overhead: Indirect materials Lubricants Supplies Power
Both merchandising and manufacturing companies	Selling, general, and administrative costs: Commissions Clerical costs, such as invoicing Shipping costs
Service organizations	Supplies, travel, clerical

*Direct labor may or may not be variable in practice. See the discussion later in this chapter.

and Decker, by contrast, will often have many variable costs; these costs will be associated with both manufacturing and distributing its products to customers.

A merchandising company like Wal-Mart or J. K. Gill will usually have a high proportion of variable costs in its cost structure. In most merchandising companies, the cost of merchandise purchased for resale, a variable cost, constitutes a very large component of total cost. Service companies, by contrast, have diverse cost structures. Some service companies, such as the Skippers restaurant chain, have fairly large variable costs because of the costs of their raw materials. On the other hand, service companies involved in consulting, auditing, engineering, dental, medical, and architectural activities have very large fixed costs in the form of expensive facilities and highly trained salaried employees.

Some of the more frequently encountered variable costs are listed in Exhibit 5–2. This exhibit is not a complete listing of all costs that can be considered variable. Moreover, some of the costs listed in the exhibit may behave more like fixed than variable costs in some organizations and in some circumstances. We will see some examples of this later in the chapter. Nevertheless, Exhibit 5–2 provides a useful listing of many of the costs that normally would be considered variable with respect to the volume of output.

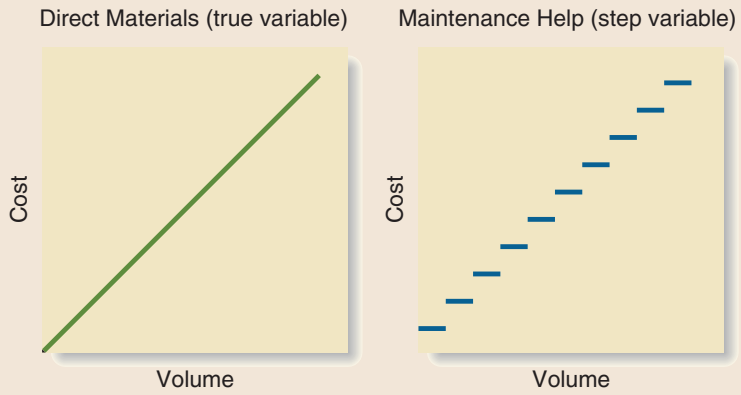
True Variable versus Step-Variable Costs

Not all variable costs have exactly the same behavior pattern. Some variable costs behave in a *true variable* or *proportionately variable* pattern. Other variable costs behave in a *step-variable* pattern.

True Variable Costs Direct materials is a true or proportionately variable cost because the amount used during a period will vary in direct proportion to the level of production activity. Moreover, any amounts purchased but not used can be stored and carried forward to the next period as inventory.

Step-Variable Costs The wages of maintenance workers are often considered to be a variable cost, but this labor cost doesn't behave in the same way as the cost of direct materials. Unlike direct materials, a maintenance worker's time can only be obtained in large chunks. Moreover, any maintenance time not utilized cannot be stored as inventory and carried forward to the next period. If the time is not used effectively, it is gone

EXHIBIT 5–3
True Variable versus Step-Variable Costs



forever. Furthermore, a maintenance crew can work at a leisurely pace if pressures are light but intensify its efforts if pressures build up. For this reason, small changes in the level of production may have no effect on the number of maintenance people employed by the company.

A resource that is obtainable only in large chunks (such as maintenance workers) and whose costs increase or decrease only in response to fairly wide changes in activity is known as a **step-variable cost.** The behavior of a step-variable cost, contrasted with the behavior of a true variable cost, is illustrated in Exhibit 5–3.

Notice that the need for maintenance help changes only with fairly wide changes in volume and that when additional maintenance time is obtained, it comes in large, indivisible chunks. Great care must be taken in working with these kinds of costs to prevent "fat" from building up in an organization. There may be a tendency to employ additional help more quickly than needed, and there is a natural reluctance to lay people off when volume declines.

The Linearity Assumption and the Relevant Range

In dealing with variable costs, we have assumed a strictly linear relationship between cost and volume, except in the case of step-variable costs. Economists correctly point out that many costs that the accountant classifies as variable actually behave in a *curvilinear* fashion. The behavior of a **curvilinear cost** is shown in Exhibit 5–4.

Although many costs are not strictly linear when plotted as a function of volume, a curvilinear cost can be satisfactorily approximated with a straight line within a narrow band of activity known as the *relevant range.* The **relevant range** is that range of activity within which the assumptions made about cost behavior are valid. For example, note that the dashed line in Exhibit 5–4 can be used as an approximation to the curvilinear cost with very little loss of accuracy within the shaded relevant range. However, outside of the relevant range this particular straight line is a poor approximation to the curvilinear cost relationship. Managers should always keep in mind that a particular assumption made about cost behavior may be very inappropriate if activity falls outside of the relevant range.

Fixed Costs

In our discussion of cost behavior patterns in Chapter 2, we stated that total fixed costs remain constant within the relevant range of activity. To continue the Nooksack Expeditions example, assume the company decides to rent a building for $500 per month to store its equipment. Within the relevant range, the *total* amount of rent paid is the same regardless

IN BUSINESS

COSTING THE TREK

Jackson Hole Llamas is owned and operated by Jill Aanonsen/Hodges and David Hodges. The company provides guided tours to remote areas of Yellowstone National Park and the Jedediah Smith Wilderness, with the llamas carrying the baggage for the multiday treks.

Jill and David operate out of their ranch in Jackson Hole, Wyoming, leading about 10 trips each summer season. All food is provided as well as tents and sleeping pads. Based on the number of guests on a trip, Jill and David will decide how many llamas will go on the trip and how many will remain on the ranch. Llamas are transported to the trailhead in a special trailer.

The company has a number of costs, some of which are listed below:

Cost	Cost Behavior
Food and beverage costs	Variable with respect to the number of guests and the length of the trip in days.
Truck and trailer operating costs	Variable with respect to the number of miles to the trailhead.
Guide wages	Step variable; Jill and David serve as the guides on most trips and hire guides only for larger groups.
Costs of providing tents	Variable with respect to the number of guests and length of the trip in days. Jackson Hole Llamas owns its tents, but they wear out through use and must be repaired or eventually replaced.
Cost of feeding llamas	Variable with respect to the number of guests, and hence the number of llamas, on a trip. [Actually, the cost of feeding llamas may *decrease* with the number of guests on a trip. When a llama is on a trek, it lives off the land—eating grasses and other vegetation found in meadows and along the trail. When a llama is left on the ranch, it may have to be fed purchased feed.]
Property taxes	Fixed.

Source: Jill Aanonsen/Hodges and David Hodges, owners and operators of Jackson Hole Llamas, www.jhllamas.com.

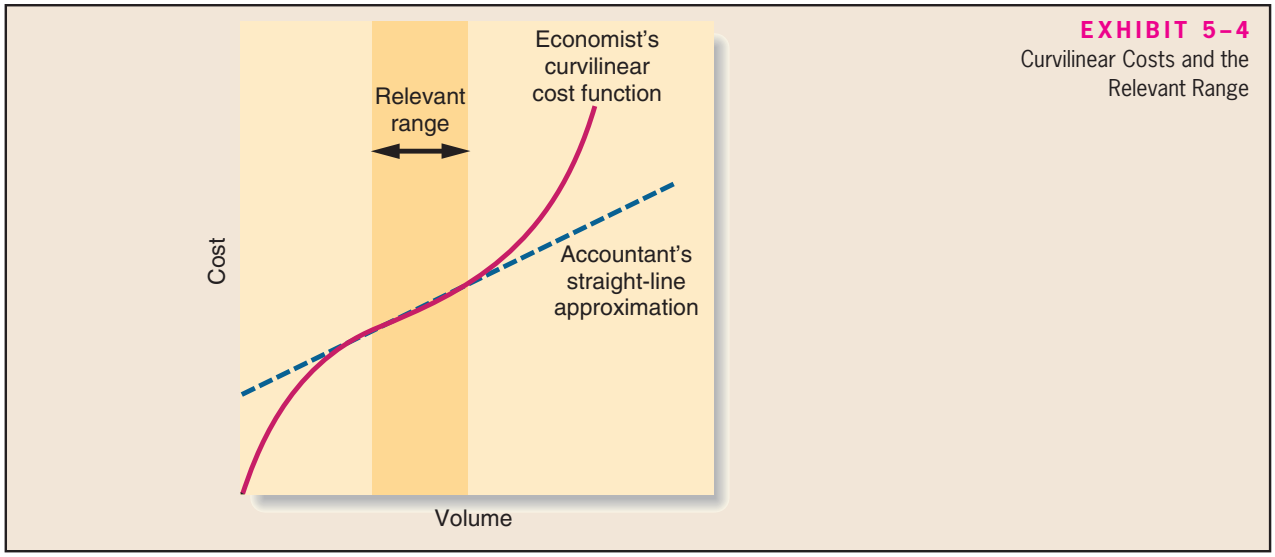
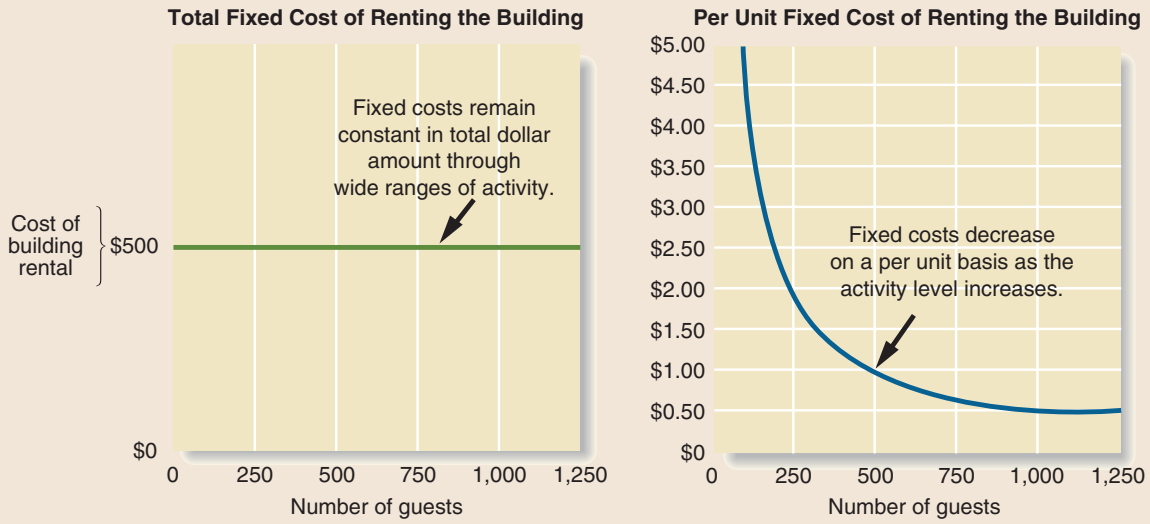


EXHIBIT 5–4
Curvilinear Costs and the Relevant Range

EXHIBIT 5–5
Fixed Cost Behavior



of the number of guests the company takes on its expeditions during any given month. This cost behavior pattern is shown graphically in Exhibit 5–5.

Since fixed costs remain constant in total, the amount of fixed cost computed on a *per unit* basis becomes progressively smaller as the level of activity increases. If Nooksack Expeditions has only 250 guests in a month, the $500 fixed rental cost would amount to $2 per guest. If there are 1,000 guests, the fixed rental cost would amount to only 50 cents per guest. This aspect of the behavior of fixed costs is also displayed in Exhibit 5–5. Note that as the number of guests increases, the average unit cost drops, but it drops at a decreasing rate. The first guests have the biggest impact on average unit costs.

This aspect of fixed costs can be confusing, although it is necessary in some contexts to express fixed costs on an average per unit basis. We found in Chapter 3, for example, that unit product costs for use in *external* financial statements contain both variable and fixed elements. However, to prevent confusion, fixed costs should be expressed in total rather than on a per-unit basis.

Types of Fixed Costs

Fixed costs are sometimes referred to as capacity costs, since they result from outlays made for buildings, equipment, skilled professional employees, and other items needed to provide the basic capacity for sustained operations. For planning purposes, fixed costs can be viewed as either *committed* or *discretionary*.

Committed Fixed Costs

Committed fixed costs relate to the investment in facilities, equipment, and basic organizational structure. Examples of such costs include depreciation of buildings and equipment, taxes on real estate, insurance, and salaries of top management and operating personnel.

The two key characteristics of committed fixed costs are that (1) they are long term in nature, and (2) they can't be significantly reduced even for short periods of time without seriously impairing the profitability or long-run goals of the organization. Even if operations are interrupted or cut back, the committed fixed costs will still continue largely unchanged. During a recession, for example, a company won't usually discharge key executives or sell off key facilities. The basic organizational structure and facilities ordinarily are kept intact. The costs of restoring them later are likely to be far greater than any short-run savings that might be realized.

Decisions to acquire major equipment or to take on other committed fixed costs involve a long planning horizon. Management should make such commitments only after careful analysis of the available alternatives. Once a decision is made to acquire committed fixed resources, the company may be locked into that decision for many years to come. Decisions relating to committed fixed costs will be examined in Chapter 14.

IN BUSINESS

SHARING OFFICE SPACE TO REDUCE COMMITTED FIXED COSTS

Even committed fixed costs may be more flexible than they would appear at first glance. Doctors in private practice have been under enormous pressure in recent years to cut costs. Dr. Edward Betz of Encino, California, reduced the committed fixed costs of maintaining his office by letting a urologist use the office on Wednesday afternoons and Friday mornings for $1,500 a month. Dr. Betz uses this time to work on paperwork at home and he makes up for the lost time in the office by treating some patients on Saturdays.

Source: Gloria Lau and Tim W. Ferguson, "Doc's Just an Employee Now," *Forbes*, May 18, 1998, pp. 162–172.

Since the amount of committed fixed costs cannot be changed in the short run, management is generally very concerned about utilizing these resources as effectively as possible.

Discretionary Fixed Costs

Discretionary fixed costs (often referred to as *managed fixed costs*) usually arise from *annual* decisions by management to spend in certain fixed cost areas. Examples of discretionary fixed costs include advertising, research, public relations, management development programs, and internships for students.

Two key differences exist between discretionary fixed costs and committed fixed costs. First, the planning horizon for a discretionary fixed cost is short term—usually a single year. By contrast, as we indicated earlier, committed fixed costs have a planning horizon that encompasses many years. Second, discretionary fixed costs can be cut for short periods of time with minimal damage to the long-run goals of the organization. For example, spending on management development programs can be reduced because of poor economic conditions. Although some unfavorable consequences may result from the cutback, it is doubtful that these consequences would be as great as those that would result if the company decided to economize during the year by laying off key personnel.

Whether a particular cost is regarded as committed or discretionary may depend on management's strategy. For example, during recessions when the level of home building is down, many construction companies lay off most of their workers and virtually disband operations. Other construction companies retain large numbers of employees on the payroll, even though the workers have little or no work to do. While these latter companies may be faced with short-term cash flow problems, it will be easier for them to respond quickly when economic conditions improve. And the higher morale and loyalty of their employees may give these companies a significant competitive advantage.

The most important characteristic of discretionary fixed costs is that management is not locked into its decisions regarding such costs. Discretionary costs can be adjusted from year to year or even perhaps during the course of a year if necessary.

IN BUSINESS

A TWIST ON FIXED AND VARIABLE COSTS

Mission Controls designs and installs automation systems for food and beverage manufacturers. At most companies, when sales drop and cost cutting is necessary, top managers lay off workers. The founders of Mission Controls decided to do something different when sales drop—they slash their own salaries before they even consider letting any of their employees go. This makes their own salaries somewhat variable, while the wages and salaries of workers act more like fixed costs. The payoff is a loyal and committed workforce.

Source: Christopher Caggiano, "Employment, Guaranteed for Life," *INC*, October 15, 2002, p. 74.

The Trend toward Fixed Costs The trend in many industries is toward greater fixed costs relative to variable costs. Chores that used to be performed by hand have been taken over by machines. For example, grocery clerks at stores like Safeway and Kroger used to key in prices by hand on cash registers. Now, most stores are equipped with bar-code readers that enter price and other product information automatically. In general, competition has created pressure to give customers more value for their money—a demand that often can only be satisfied by automating business processes. For example, an H & R Block employee used to fill out tax returns for customers by hand and the advice given to a customer largely depended on the knowledge of that particular employee. Now, sophisticated computer software is used to complete tax returns, and the software provides the customer with tax planning and other advice tailored to the customer's needs based on the accumulated knowledge of many experts.

As automation intensifies, the demand for "knowledge" workers—those who work primarily with their minds rather than their muscles—has grown tremendously. Since knowledge workers tend to be salaried, highly trained, and difficult to replace, the costs of compensating these workers are often relatively fixed and are committed rather than discretionary.

Is Labor a Variable or a Fixed Cost? As the preceding discussion suggests, wages and salaries may be fixed or variable. The behavior of wage and salary costs will differ from one country to another, depending on labor regulations, labor contracts, and custom. In some countries, such as France, Germany, and Japan, management has little flexibility in adjusting the labor force to changes in business activity. In countries such as the United States and the United Kingdom, management typically has much greater latitude. However, even in these less restrictive environments, managers may choose to treat employee compensation as a fixed cost for several reasons.

First, many managers are reluctant to decrease their workforce in response to short-term declines in sales. These managers realize that the success of their businesses hinges on retaining highly skilled and trained employees. If these valuable workers are laid off, it is unlikely that they would ever return or be easily replaced. Furthermore, laying off workers undermines the morale of those employees who remain.

Second, managers do not want to be caught with a bloated payroll in an economic downturn. Therefore, managers are reluctant to add employees in response to short-term increases in sales. Instead, more and more companies rely on temporary and part-time workers to take up the slack when their permanent, full-time employees are unable to handle all of the demand for their products and services. In such companies, labor costs are a curious mixture of fixed and variable costs.

IN BUSINESS

LABOR AT SOUTHWEST AIRLINES

Starting with a $10,000 investment in 1966, Herb Kelleher built Southwest Airlines into the most profitable airline in the United States. Prior to stepping down as president and CEO of the airline in 2001, Kelleher wrote: "The thing that would disturb me most to see after I'm no longer CEO is layoffs at Southwest. Nothing kills your company's culture like layoffs. Nobody has ever been furloughed here, and that is unprecedented in the airline industry. It's been a huge strength of ours . . . We could have furloughed at various times and been more profitable, but I always thought that was shortsighted. You want to show your people that you value them and you're not going to hurt them just to get a little money in the short run."

Because of this commitment by management to the company's employees, all wages and salaries are basically committed fixed costs at Southwest Airlines.

Source: Herb Kelleher, "The Chairman of the Board Looks Back," *Fortune*, May 28, 2001, pp. 63–76.

Many major companies have undergone waves of downsizing in recent years in which large numbers of employees—particularly middle managers—have lost their jobs.

This downsizing may seem to suggest that even management salaries should be regarded as variable costs, but this would not be a valid conclusion. Downsizing has largely been the result of attempts to reengineer business processes and cut costs rather than a response to a decline in sales activity. This underscores an important, but subtle, point. Fixed costs can change—they just don't change in response to small changes in activity.

In sum, there is no clear-cut answer to the question "Is labor a variable or fixed cost?" It depends on how much flexibility management has and management's strategy. Nevertheless, unless otherwise stated, we will assume in this text that direct labor is a variable cost. This assumption is more likely to be valid for companies in the United States than in countries where employment laws permit much less flexibility.

IN BUSINESS

THE REGULATORY BURDEN

Peter F. Drucker, a renowned observer of business and society, claims that "the driving force behind the steady growth of temps [and outsourcing of work] . . . is the growing burden of rules and regulations for employers." U.S. laws and regulations concerning employees require companies to file multiple reports—and any breach, even if unintentional, can result in punishment. According to the Small Business Administration, the owner of a small or midsize business spends up to a quarter of his or her time on employment-related paperwork and the cost of complying with government regulations (including tax report preparation) is over $5,000 per employee per year. "No wonder that employers . . . complain bitterly that they have no time to work on products and services. . . . They no longer chant the old mantra 'People are our greatest asset.' Instead, they claim 'People are our greatest liability.'" To the extent that the regulatory burden leads to a decline in permanent full-time employees and an increase in the use of temporary employees and outsourcing, labor costs are converted from fixed to variable costs. While this is not the intent of the regulations, it is a consequence.

Source: Peter F. Drucker, "They're Not Employees, They're People," *Harvard Business Review*, February 2002.

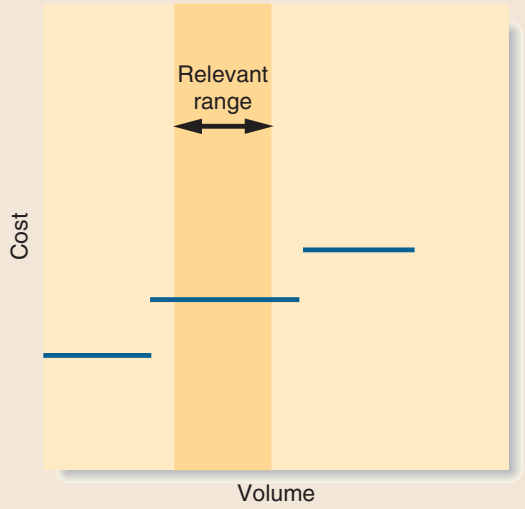
Fixed Costs and the Relevant Range

The concept of the relevant range, which was introduced in the discussion of variable costs, is also important in understanding fixed costs—particularly discretionary fixed costs. The levels of discretionary fixed costs are typically decided at the beginning of the year and depend on the needs of planned programs such as advertising and training. The scope of these programs will depend, in turn, on the overall anticipated level of activity for the year. At very high levels of activity, programs are often broadened or expanded. For example, if the company hopes to increase sales by 25%, it would probably plan for much larger advertising costs than if no sales increase were planned. So the *planned* level of activity might affect total discretionary fixed costs. However, once the total discretionary fixed costs have been budgeted, they are unaffected by the *actual* level of activity. For example, once the advertising budget has been established and spent, it will not be affected by how many units are actually sold. Therefore, the cost is fixed with respect to the *actual* number of units sold.

Discretionary fixed costs are easier to adjust than committed fixed costs. They also tend to be less "lumpy." Committed fixed costs consist of costs such as buildings, equipment, and the salaries of key personnel. It is difficult to buy half a piece of equipment or to hire a quarter of a product-line manager, so the step pattern depicted in Exhibit 5–6 is typical for such costs. The relevant range of activity for a fixed cost is the range of activity over which the graph of the cost is flat as in Exhibit 5–6. As a company expands its level of activity, it may outgrow its present facilities, or the key management team may need to be expanded. The result, of course, will be increased committed fixed costs as larger facilities are built and as new management positions are created.

One reaction to the step pattern depicted in Exhibit 5–6 is to say that discretionary and committed fixed costs are really just step-variable costs. To some extent this is true, since *almost* all costs can be adjusted in the long run. There are two major differences,

EXHIBIT 5–6
Fixed Costs and the Relevant Range



however, between the step-variable costs depicted earlier in Exhibit 5–3 and the fixed costs depicted in Exhibit 5–6.

The first difference is that the step-variable costs can often be adjusted quickly as conditions change, whereas once fixed costs have been set, they usually can't be changed easily. A step-variable cost such as maintenance labor, for example, can be adjusted upward or downward by hiring and laying off maintenance workers. By contrast, once a company has signed a lease for a building, it is locked into that level of lease cost for the life of the contract.

The second difference is that the *width of the steps* depicted for step-variable costs is much narrower than the width of the steps depicted for the fixed costs in Exhibit 5–6. The width of the steps relates to volume or level of activity. For step-variable costs, the width of a step might be 40 hours of activity or less if one is dealing, for example, with maintenance labor cost. For fixed costs, however, the width of a step might be *thousands* or even *tens of thousands* of hours of activity. In essence, the width of the steps for step-variable costs is generally so narrow that these costs can be treated essentially as variable costs for most purposes. The width of the steps for fixed costs, on the other hand, is so wide that these costs should be treated as entirely fixed within the relevant range.

Mixed Costs

A **mixed cost** contains both variable and fixed cost elements. Mixed costs are also known as semivariable costs. To continue the Nooksack Expeditions example, the company must pay a license fee of $25,000 per year plus $3 per rafting party to the state's Department of Natural Resources. If the company runs 1,000 rafting parties this year, then the total fees paid to the state would be $28,000, made up of $25,000 in fixed cost plus $3,000 in variable cost. The behavior of this mixed cost is shown graphically in Exhibit 5–7.

Even if Nooksack fails to attract any customers, the company will still have to pay the license fee of $25,000. This is why the cost line in Exhibit 5–7 intersects the vertical cost axis at the $25,000 point. For each rafting party the company organizes, the total cost of the state fees will increase by $3. Therefore, the total cost line slopes upward as the variable cost element is added to the fixed cost element.

Since the mixed cost in Exhibit 5–7 is represented by a straight line, the following equation for a straight line can be used to express the relationship between a mixed cost and the level of activity:

$$Y = a + bX$$

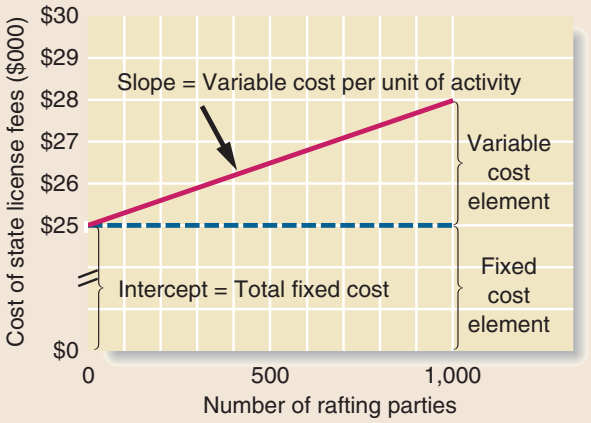


EXHIBIT 5–7
Mixed Cost Behavior

In this equation,

Y = The total mixed cost
a = The total fixed cost (the vertical intercept of the line)
b = The variable cost per unit of activity (the slope of the line)
X = The level of activity

Since the variable cost per unit equals the slope of the straight line, the steeper the slope, the higher the variable cost per unit.

In the case of the state fees paid by Nooksack Expeditions, the equation is written as follows:

$$Y = \$25{,}000 + \$3.00X$$

Total mixed cost; Total fixed cost; Variable cost per unit of activity; Activity level

This equation makes it very easy to calculate what the total mixed cost would be for any level of activity within the relevant range. For example, suppose that the company expects to organize 800 rafting parties in the next year. The total state fees would be $27,400 calculated as follows:

$$Y = \$25{,}000 + (\$3.00 \text{ per rafting party} \times 800 \text{ rafting parties})$$
$$= \$27{,}400$$

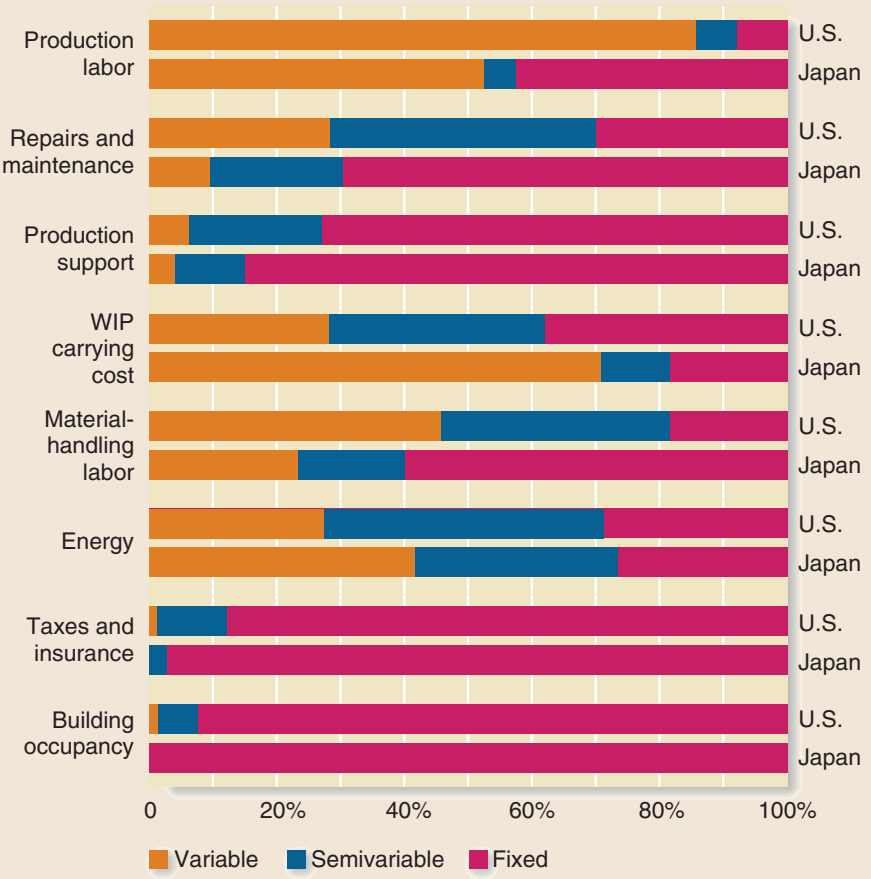
IN BUSINESS

COST BEHAVIOR IN THE U.S. AND JAPAN

A total of 257 American and 40 Japanese manufacturing companies responded to a questionnaire concerning their management accounting practices. Among other things, the companies were asked whether they classified certain costs as variable, semivariable, or fixed. Some of the results are summarized in Exhibit 5–8. Note that companies do not all classify costs in the same way. For example, roughly 45% of the U.S. companies classify material-handling labor costs as variable, 35% as semivariable, and 20% as fixed. Also note that the Japanese companies are much more likely than U.S. companies to classify labor costs as fixed.

Source: NAA Tokyo Affiliate, "Management Accounting in the Advanced Management Surrounding—Comparative Study on Survey in Japan and U.S.A."

EXHIBIT 5–8
Percentages of Companies Classifying Specific Costs as Variable, Semivariable, or Fixed



The Analysis of Mixed Costs

In practice, mixed costs are very common. For example, the cost of providing X-ray services to patients at the Harvard Medical School Hospital is a mixed cost. There are substantial fixed costs for equipment depreciation and for the salaries of radiologists and technicians, but there are also variable costs for X-ray film, power, and supplies. At Southwest Airlines, maintenance costs are a mixed cost. The company incurs fixed costs for renting maintenance facilities and for keeping skilled mechanics on the payroll, but the costs of replacement parts, lubricating oils, tires, and so forth, are variable with respect to how often and how far the company's aircraft are flown.

The fixed portion of a mixed cost represents the minimum cost of having a service *ready and available* for use. The variable portion represents the cost incurred for *actual consumption* of the service. The variable element varies in proportion to the amount of service that is consumed.

How does management go about actually estimating the fixed and variable components of a mixed cost? The most common methods used in practice and discussed later in this text are *account analysis* and the *engineering approach.*

In **account analysis,** each account under consideration is classified as either variable or fixed based on the analyst's prior knowledge of how the cost in the account behaves. For example, direct materials would be classified as variable and a building lease cost would be classified as fixed because of the nature of those costs. The total fixed cost of an organization is the sum of the costs for the accounts that have been classified as fixed. The

variable cost per unit is estimated by dividing the sum of the costs for the accounts that have been classified as variable by the total activity.

The **engineering approach** to cost analysis involves a detailed analysis of what cost behavior should be, based on an industrial engineer's evaluation of the production methods to be used, the materials specifications, labor requirements, equipment usage, efficiency of production, power consumption, and so on. For example, Pizza Hut might use the engineering approach to estimate the cost of serving a particular take-out pizza. The cost of the pizza would be estimated by carefully costing the specific ingredients used to make the pizza, the power consumed to cook the pizza, and the cost of the container the pizza is delivered in. The engineering approach must be used in those situations where no past experience is available concerning activity and costs. In addition, it is sometimes used together with other methods to improve the accuracy of cost analysis.

Account analysis works best when analyzing costs at a fairly aggregated level, such as the cost of serving patients in the emergency room (ER) of Cook County General Hospital. The costs of drugs, supplies, forms, wages, equipment, and so on, can be roughly classified as variable or fixed and a mixed cost formula for the overall cost of the emergency room can be estimated fairly quickly. However, this method does not recognize that some of the accounts may have both fixed and variable cost elements. For example, the cost of electricity for the ER is a mixed cost. Most of the electricity is used for heating and lighting and is a fixed cost. However, the consumption of electricity increases with activity in the ER since diagnostic equipment, operating theater lights, defibrillators, and so on, all consume electricity. The most effective way to estimate the fixed and variable elements of such a mixed cost may be to analyze past records of cost and activity data. These records should reveal whether electrical costs vary significantly with the number of patients and if so, by how much. The remainder of this section will be concerned with how to conduct such an analysis of past cost and activity data.

IN BUSINESS

OPERATIONS DRIVE COSTS

White Grizzly Adventures is a snowcat skiing and snowboarding company in Meadow Creek, British Columbia, that is owned and operated by Brad and Carole Karafil. The company shuttles 12 guests to the top of the company's steep and tree-covered terrain in a single snowcat. Guests stay as a group at the company's lodge for a fixed number of days and are provided healthful gourmet meals.

Brad and Carole must decide each year when snowcat operations will begin in December and when they will end in early spring, and how many nonoperating days to schedule between groups of guests for maintenance and rest. This decision affects a variety of costs. Examples of costs that are fixed and variable with respect to the number of days of operation at White Grizzly include:

Cost	Cost Behavior—Fixed or Variable with Respect to Days of Operation
Property taxes	Fixed
Summer road maintenance and tree clearing	Fixed
Lodge depreciation	Fixed
Snowcat operator and guides	Variable
Cooks and lodge help	Variable
Snowcat depreciation	Variable
Snowcat fuel	Variable
Food*	Variable

*The costs of food served to guests theoretically depend on the number of guests in residence. However, the lodge is basically always filled to its capacity of 12 persons when the snowcat operation is running, so food costs can be considered to be driven by the days of operation.

Source: Brad & Carole Karafil, owners and operators of White Grizzly Adventures, www.whitegrizzly.com.

MANAGERIAL ACCOUNTING IN ACTION
The Issue

BRENTLINE HOSPITAL

Dr. Derek Chalmers, the chief executive officer of Brentline Hospital, motioned Kinh Nguyen, the chief financial officer of the hospital, into his office.

Derek: Kinh, come on in.
Kinh: What can I do for you?
Derek: Well for one, could you get the government to rescind the bookcase full of regulations against the wall over there?
Kinh: Sorry, that's a bit beyond my authority.
Derek: Just wishing, Kinh. Actually, I wanted to talk to you about our maintenance expenses. I don't usually pay attention to such things, but these expenses seem to be bouncing around a lot. Over the last half year or so they have been as low as $7,400 and as high as $9,800 per month.
Kinh: Actually, that's a pretty normal variation in those expenses.
Derek: Well, we budgeted a constant $8,400 a month. Can't we do a better job of predicting what these costs are going to be? And how do we know when we've spent too much in a month? Shouldn't there be some explanation for these variations?
Kinh: Now that you mention it, we are in the process of tightening up our budgeting process. Our first step is to break all of our costs down into fixed and variable components.
Derek: How will that help?
Kinh: Well, that will permit us to predict what the level of costs will be. Some costs are fixed and shouldn't change much. Other costs go up and down as our activity goes up and down. The trick is to figure out what is driving the variable component of the costs.
Derek: What about the maintenance costs?
Kinh: My guess is that the variations in maintenance costs are being driven by our overall level of activity. When we treat more patients, our equipment is used more intensively, which leads to more maintenance expense.
Derek: How would you measure the level of overall activity? Would you use patient-days?
Kinh: I think so. Each day a patient is in the hospital counts as one patient-day. The greater the number of patient-days in a month, the busier we are. Besides, our budgeting is all based on projected patient-days.
Derek: Okay, so suppose you are able to break the maintenance costs down into fixed and variable components. What will that do for us?
Kinh: Basically, I will be able to predict what maintenance costs should be as a function of the number of patient-days.
Derek: I can see where that would be useful. We could use it to predict costs for budgeting purposes.
Kinh: We could also use it as a benchmark. Based on the actual number of patient-days for a period, I can predict what the maintenance costs should have been. We can compare this to the actual spending on maintenance.
Derek: Sounds good to me. Let me know when you get the results.

Diagnosing Cost Behavior with a Scattergraph Plot

LEARNING OBJECTIVE 2
Use a scattergraph plot to diagnose cost behavior.

Kinh Nguyen began his analysis of maintenance costs by collecting cost and activity data for a number of recent months. Those data are displayed below:

Month	Activity Level: Patient-Days	Maintenance Cost Incurred
January	5,600	$7,900
February	7,100	$8,500
March	5,000	$7,400
April	6,500	$8,200
May	7,300	$9,100
June	8,000	$9,800
July	6,200	$7,800

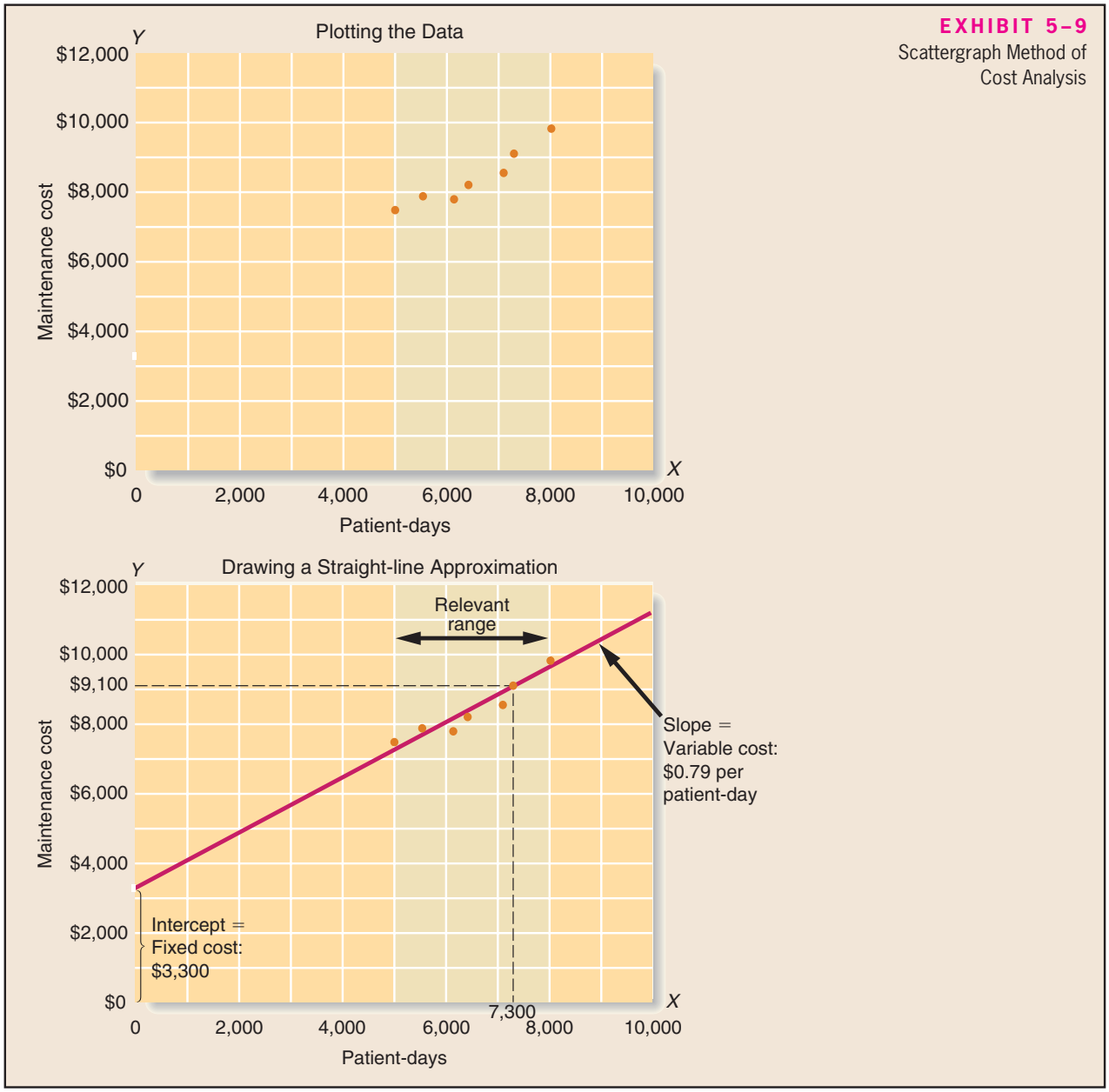


EXHIBIT 5–9
Scattergraph Method of Cost Analysis

The first step in analyzing the cost and activity data is to plot the data on a scattergraph. This plot will immediately reveal any nonlinearities or other problems with the data. The scattergraph of maintenance costs versus patient-days at Brentline Hospital is reproduced in the first panel of Exhibit 5–9. Two things should be noted about this scattergraph:

1. The total maintenance cost, *Y*, is plotted on the vertical axis. Cost is known as the **dependent variable,** since the amount of cost incurred during a period depends on the level of activity for the period. (That is, as the level of activity increases, total cost will also ordinarily increase.)
2. The activity, *X* (patient-days in this case), is plotted on the horizontal axis. Activity is known as the **independent variable,** since it causes variations in the cost.

From the scattergraph, it is evident that maintenance costs do increase with the number of patient-days. In addition, the scattergraph reveals that the relation between maintenance costs and patient-days is approximately *linear*. In other words, the points lie more or less along a straight line. Such a straight line has been drawn using a ruler in the second panel of Exhibit 5–9. Cost behavior is said to be **linear** whenever a straight line is a reasonable approximation for the relation between cost and activity. Note that the data points do not fall exactly on the straight line. This will almost always happen in practice; the relation is seldom perfectly linear.

Note that the straight line in Exhibit 5–9 has been drawn through the point representing 7,300 patient-days and a total maintenance cost of $9,100. Drawing the straight line through one of the data points allows the analyst to make a quick-and-dirty estimate of variable and fixed costs. The vertical intercept where the straight line crosses the *Y* axis—in this case, about $3,300—is the rough estimate of the fixed cost. The variable cost can be quickly estimated by subtracting the estimated fixed cost from the total cost at the point lying on the straight line.

Total maintenance cost for 7,300 patient-days (a point falling on the straight line)	$9,100
Less estimated fixed cost (the vertical intercept)	3,300
Estimated total variable cost for 7,300 patient-days	$5,800

The average variable cost per unit at 7,300 patient-days is computed as follows:

$$\begin{aligned}\text{Variable cost per unit} &= \$5{,}800 \div 7{,}300 \text{ patient-days} \\ &= \$0.79 \text{ per patient-day (rounded)}\end{aligned}$$

Combining the estimate of the fixed cost and the estimate of the variable cost per patient-day, we can write the relation between cost and activity as follows:

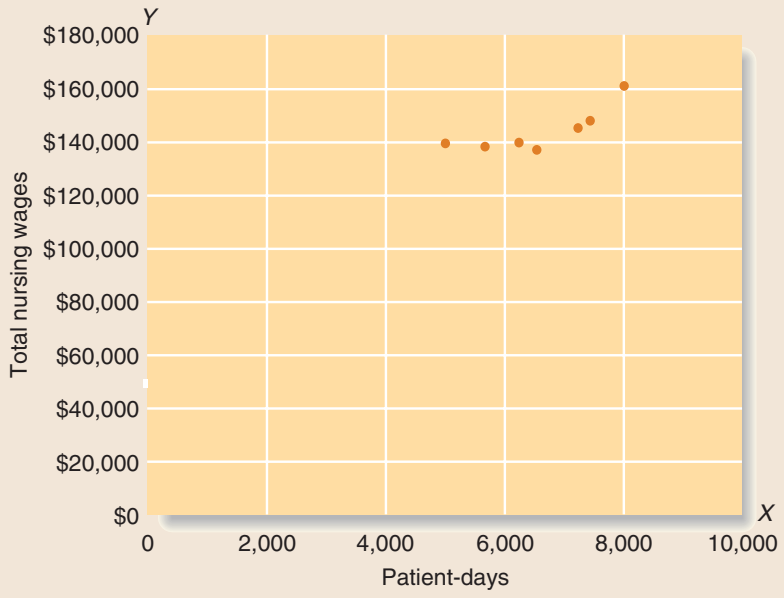
$$Y = \$3{,}300 + \$0.79X$$

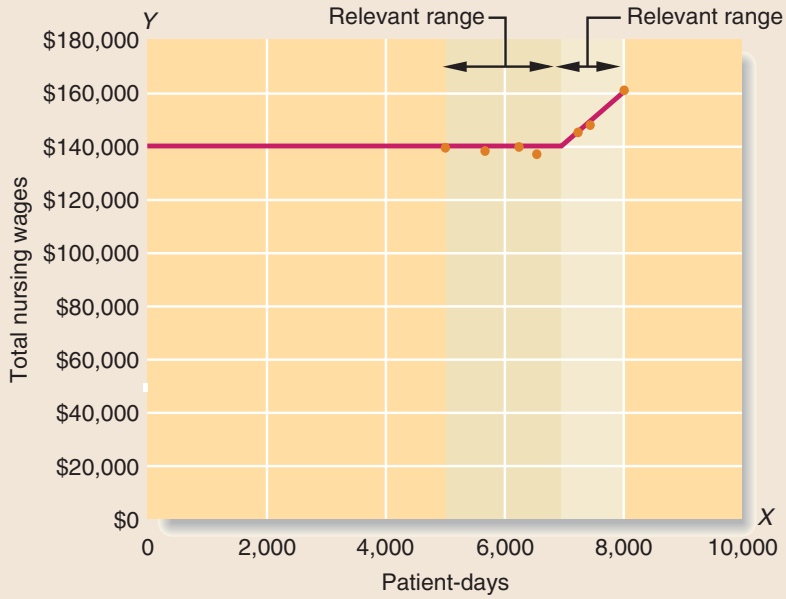
where *X* is the number of patient-days.

We hasten to add that this *is* a quick-and-dirty method of estimating the fixed and variable cost elements of a mixed cost; it is seldom used in practice when the financial implications of a decision based on the data are significant. However, setting aside the estimates of the fixed and variable cost elements, plotting the data on a scattergraph is an essential diagnostic step that is too often overlooked. Suppose, for example, we had been interested in the relation between total nursing wages and the number of patient-days at the hospital. The permanent, full-time nursing staff can handle up to 7,000 patient-days in a month. Beyond that level of activity, part-time nurses must be called in to help out. The cost and activity data for nurses are plotted on the scattergraph in Exhibit 5–10. Looking at that scattergraph, it is evident that two straight lines would do a much better job of fitting the data than a single straight line. Up to 7,000 patient-days, total nursing wages are essentially a fixed cost. Above 7,000 patient-days, total nursing wages are a mixed cost. This happens because, as stated above, the permanent, full-time nursing staff can handle up to 7,000 patient-days in a month. Above that level, part-time nurses are called in to help, which adds to the cost. Consequently, two straight lines (and two equations) would be used to represent total nursing wages—one for the relevant range of 5,600 to 7,000 patient-days and one for the relevant range of 7,000 to 8,000 patient-days.

As another example, suppose that Brentline Hospital management is interested in the relation between the hospital's telephone costs and patient-days. Patients are billed directly for their use of telephones, so those costs do not appear on the hospital's cost records. The telephone costs of concern to management are the charges for the staff's use of telephones. The data for this cost are plotted in Exhibit 5–11. It is evident from that plot that while the telephone costs do vary from month to month, they are not related to patient-days. Something other than patient-days is driving the telephone bills. Therefore,

EXHIBIT 5–10
More than One Relevant Range





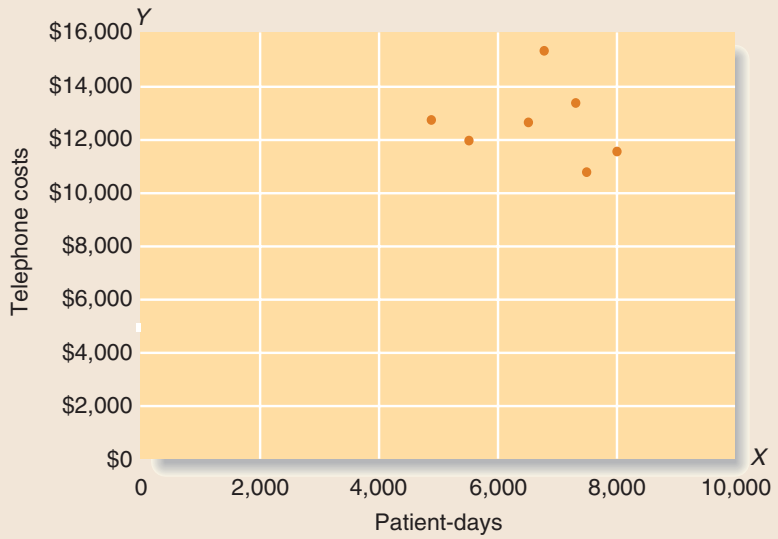
it would not make sense to analyze this cost any further by attempting to estimate a variable cost per patient-day for telephone costs. Plotting the data helps the cost analyst to diagnose such situations.

The High-Low Method

LEARNING OBJECTIVE 3
Analyze a mixed cost using the high-low method.

In addition to the quick-and-dirty method described in the preceding section, more precise methods are available for estimating fixed and variable costs. However, it must be emphasized that fixed and variable costs should be computed only if a scattergraph plot confirms that the relation is approximately linear. In the case of maintenance costs at Brentline Hospital, the relation does appear to be linear. In the case of telephone costs,

EXHIBIT 5–11
A Diagnostic Scattergraph Plot



there isn't any clear relation between telephone costs and patient-days, so there is no point in estimating how much of the cost varies with patient-days.

Assuming that the scattergraph plot indicates a linear relation between cost and activity, the fixed and variable cost elements of a mixed cost can be estimated using the *high-low method* or the *least-squares regression method*. The high-low method is based on the rise-over-run formula for the slope of a straight line. As discussed above, if the relation between cost and activity can be represented by a straight line, then the slope of the straight line is equal to the variable cost per unit of activity. Consequently, the following formula can be used to estimate the variable cost.

$$\text{Variable cost} = \text{Slope of the line} = \frac{\text{Rise}}{\text{Run}} = \frac{Y_2 - Y_1}{X_2 - X_1}$$

To analyze mixed costs with the **high-low method,** you begin by identifying the period with the lowest level of activity and the period with the highest level of activity. The period with the lowest activity is selected as the first point in the above formula and the period with the highest activity is selected as the second point. Consequently, the formula becomes:

$$\text{Variable cost} = \frac{Y_2 - Y_1}{X_2 - X_1} = \frac{\text{Cost at the high activity level} - \text{Cost at the low activity level}}{\text{High activity level} - \text{Low activity level}}$$

or

$$\text{Variable cost} = \frac{\text{Change in cost}}{\text{Change in activity}}$$

Therefore, when the high-low method is used, the variable cost is estimated by dividing the difference in cost between the high and low levels of activity by the change in activity between those two points.

Using the high-low method, we first identify the periods with the highest and lowest *activity*—in this case, June and March. We then use the activity and cost data from these two periods to estimate the variable cost component as follows:

	Patient-Days	Maintenance Cost Incurred
High activity level (June)	8,000	$9,800
Low activity level (March)	5,000	7,400
Change	3,000	$2,400

$$\text{Variable cost} = \frac{\text{Change in cost}}{\text{Change in activity}} = \frac{\$2{,}400}{3{,}000 \text{ patient-days}} = \$0.80 \text{ per patient-day}$$

Having determined that the variable rate for maintenance cost is 80 cents per patient-day, we can now determine the amount of fixed cost. This is done by taking total cost at *either* the high or the low activity level and deducting the variable cost element. In the computation below, total cost at the high activity level is used in computing the fixed cost element:

$$\begin{aligned}\text{Fixed cost element} &= \text{Total cost} - \text{Variable cost element}\\ &= \$9{,}800 - (\$0.80 \text{ per patient-day} \times 8{,}000 \text{ patient-days})\\ &= \$3{,}400\end{aligned}$$

Both the variable and fixed cost elements have now been isolated. The cost of maintenance can be expressed as $3,400 per month plus 80 cents per patient-day.

The cost of maintenance can also be expressed in terms of the equation for a straight line as follows:

$$Y = \$3{,}400 + \$0.80X$$

Y: Total maintenance cost

X: Total patient-days

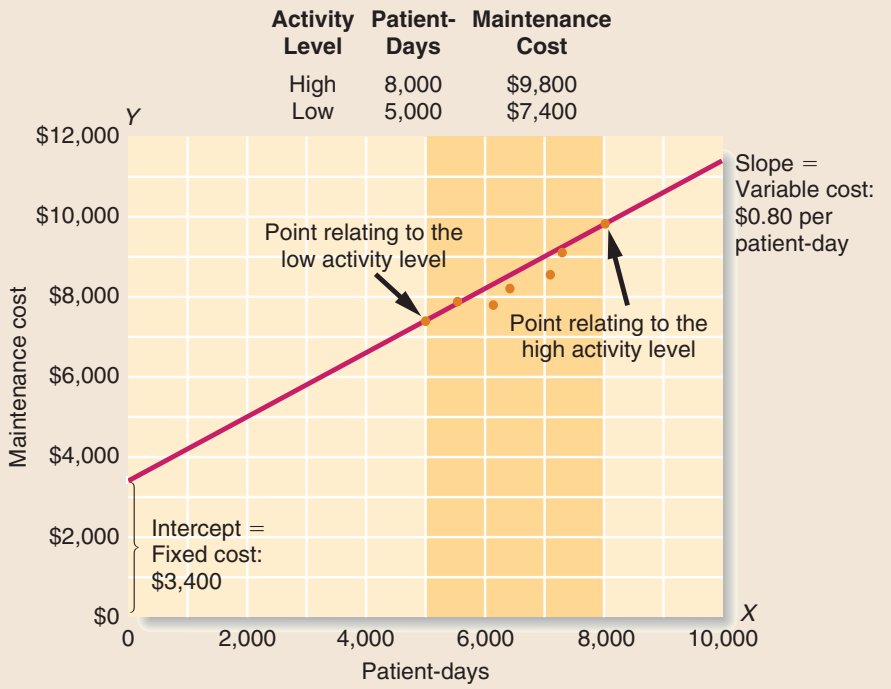
The data used in this illustration are shown graphically in Exhibit 5–12. Notice that a straight line has been drawn through the points corresponding to the low and high levels of activity. In essence, that is what the high-low method does—it draws a straight line through those two points.

Sometimes the high and low levels of activity don't coincide with the high and low amounts of cost. For example, the period that has the highest level of activity may not have the highest amount of cost. Nevertheless, the costs at the highest and lowest levels of *activity* are always used to analyze a mixed cost under the high-low method. The reason is that the analyst would like to use data that reflect the greatest possible variation in activity.

The high-low method is very simple to apply, but it suffers from a major (and sometimes critical) defect—it utilizes only two data points. Generally, two data points are not enough to produce accurate results. Additionally, periods in which the activity level is unusually low or unusually high will tend to produce inaccurate results. A cost formula that is estimated solely using data from these unusual periods may misrepresent the true cost relationship that holds during normal periods. Such a distortion is evident in Exhibit 5–12. The straight line should probably be shifted down somewhat so that it is closer to more of the data points. For these reasons, other methods of cost analysis that utilize a greater number of data points will generally be more accurate than the high-low method. A manager who chooses to use the high-low method should do so with a full awareness of the method's limitations.

Fortunately, modern computer software makes it very easy to use sophisticated statistical methods, such as *least-squares regression,* that use all of the data and that are capable of providing much more information than just the estimates of variable and fixed

EXHIBIT 5–12
High-Low Method of Cost Analysis



costs. The details of these statistical methods are beyond the scope of this text, but the basic approach is discussed below. Nevertheless, even if the least-squares regression approach is used, it is always a good idea to plot the data in a scattergraph. By simply looking at the scattergraph, you can quickly verify whether it makes sense to fit a straight line to the data using least-squares regression or some other method.

The Least-Squares Regression Method

The **least-squares regression method,** unlike the high-low method, uses all of the data to separate a mixed cost into its fixed and variable components. A *regression line* of the form $Y = a + bX$ is fitted to the data, where a represents the total fixed cost and b represents the variable cost per unit of activity. The basic idea underlying the least-squares regression method is illustrated in Exhibit 5–13 using hypothetical data points. Notice from the exhibit that the deviations from the plotted points to the regression line are measured vertically on the graph. These vertical deviations are called the regression errors. There is nothing mysterious about the least-squares regression method. It simply computes the regression line that minimizes the sum of these squared errors. The formulas that accomplish this are fairly complex and involve numerous calculations, but the principle is simple.

Fortunately, computers are adept at carrying out the computations required by the least-squares regression formulas. The data—the observed values of X and Y—are entered into the computer, and software does the rest. In the case of the Brentline Hospital maintenance cost data, a statistical software package on a personal computer can calculate the following least-squares regression estimates of the total fixed cost (a) and the variable cost per unit of activity (b):

$$a = \$3{,}431$$

$$b = \$0.759$$

Therefore, using the least-squares regression method, the fixed element of the maintenance cost is $3,431 per month and the variable portion is 75.9 cents per patient-day.

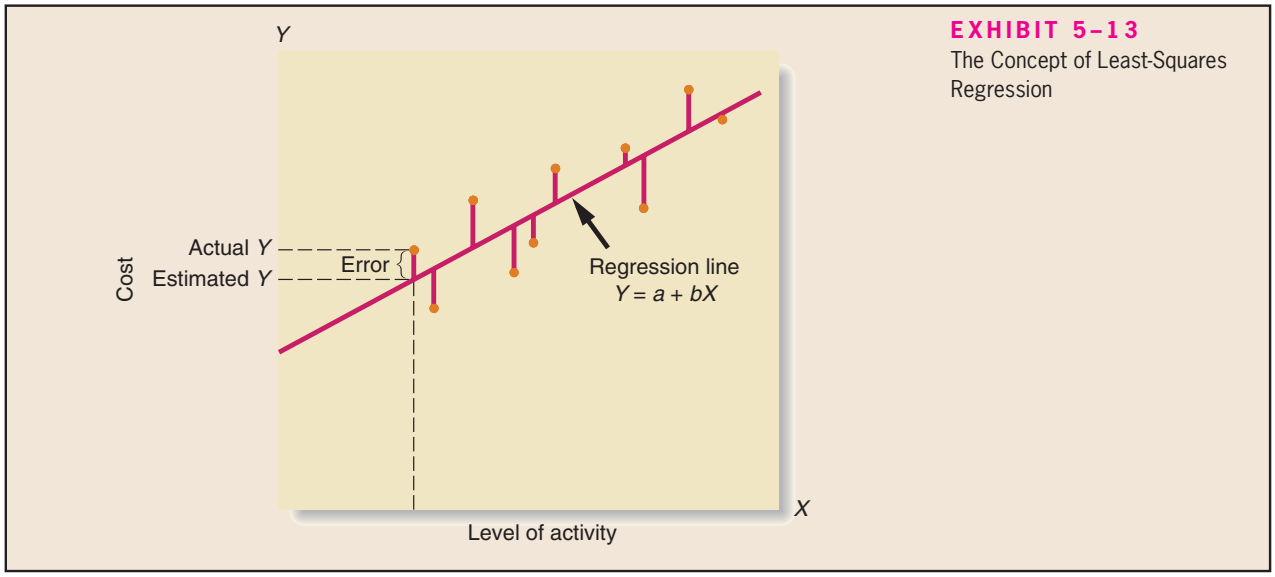


EXHIBIT 5–13
The Concept of Least-Squares Regression

In terms of the linear equation $Y = a + bX$, the cost formula can be written as

$$Y = \$3{,}431 + \$0.759X$$

where activity (X) is expressed in patient-days.

While a statistical software application was used in this example to calculate the values of a and b, the estimates can also be computed using a spreadsheet application such as Microsoft® Excel. In Appendix 5A to this chapter, we show how this can be done.

In addition to estimates of the intercept (fixed cost) and slope (variable cost per unit), least-squares regression software ordinarily provides a number of other very useful statistics. One of these statistics is the R^2, which is a measure of "goodness of fit." The $\boldsymbol{R^2}$ tells us the percentage of the variation in the dependent variable (cost) that is explained by variation in the independent variable (activity). The R^2 varies from 0% to 100%, and the higher the percentage, the better. In the case of the Brentline Hospital maintenance cost data, the R^2 is 0.90, which indicates that 90% of the variation in maintenance costs is explained by the variation in patient-days. This is reasonably high and is an indication of a good fit. On the other hand, a low R^2 would be an indication of a poor fit. You should always plot the data in a scattergraph, but it is particularly important to check the data visually when the R^2 is low. A quick look at the scattergraph can reveal that there is little real relation between the cost and the activity or that the relation is something other than a simple straight line. In such cases, additional analysis would be required.

IN BUSINESS

MANAGING POWER CONSUMPTION

The Tata Iron Steel Company Ltd. is one of the largest companies in India. Because of an unreliable electrical supply, the company is faced with frequent power shortages and must carefully manage its power consumption—allocating scarce power to the most profitable uses. Estimating the power requirements of each processing station in the steel mill was the first step in building a model to better manage power consumption. Management used simple least-squares regression to estimate the fixed and variable components of the power load. Total power consumption was the dependent variable and tons of steel processed was the independent variable. The fixed component estimated from the least-squares regression was the fixed power consumption (in KWHs) per month and the variable component was the power consumption (again in KWHs) per ton of steel processed.

Source: "How Tata Steel Optimized Its Results," *The Management Accountant* (India), May 1996, pp. 372–376.

MANAGERIAL ACCOUNTING IN ACTION
The Wrap-up

BRENTLINE HOSPITAL

After completing the analysis of maintenance costs, Kinh Nguyen met with Dr. Derek Chalmers to discuss the results.

Kinh: We used least-squares regression analysis to estimate the fixed and variable components of maintenance costs. According to the results, the fixed cost per month is $3,431 and the variable cost per patient-day is 75.9 cents.

Derek: Okay, so if we plan for 7,800 patient-days next month, what is your estimate of the maintenance costs?

Kinh: That will take just a few seconds to figure out. [Kinh wrote the following calculations on a pad of paper.]

Fixed costs	$3,431
Variable costs:	
7,800 patient-days × $0.759 per patient-day	5,920
Total expected maintenance costs	$9,351

Derek: Nine thousand three hundred and fifty *one* dollars; isn't that a bit *too* precise?

Kinh: Sure. I don't really believe the maintenance costs will be exactly this figure. However, based on the information we have, this is the best estimate we can come up with.

Derek: Don't let me give you a hard time. Even though it is an estimate, it will be a lot better than just guessing like we have done in the past. Thanks. I hope to see more of this kind of analysis.

Multiple Regression Analysis

In the discussion thus far, we have assumed that a single factor such as patient-days drives the variable cost component of a mixed cost. This assumption is acceptable for many mixed costs, but in some situations the variable cost element may be driven by a number of factors. For example, shipping costs may depend on both the number of units shipped *and* the weight of the units. In a situation such as this, *multiple regression* is necessary. **Multiple regression** is an analytical method that is used when the dependent variable (i.e., cost) is caused by more than one factor. Although adding more factors, or variables, makes the computations more complex, the principles involved are the same as in the simple least-squares regressions discussed above.

The Contribution Format Income Statement

LEARNING OBJECTIVE 4
Prepare an income statement using the contribution format.

Once costs have been separated into fixed and variable elements, what is done with the data? We have already answered this question somewhat by showing how a cost formula can be used to predict costs. To answer this question more fully will require most of the remainder of this text, since much of what the manager does requires an understanding of cost behavior. One immediate and very significant application of the ideas we have developed, however, is found in a new income statement format known as the **contribution approach.** The unique thing about the contribution approach is that it provides managers with an income statement geared directly to cost behavior.

Why a New Income Statement Format?

An income statement prepared using the *traditional approach*, as illustrated in Chapter 2, is not organized in terms of cost behavior. Rather, it is organized in a "functional" format—emphasizing the functions of production, administration, and sales. No attempt is made to distinguish between the behavior of costs included under each functional heading. Under the heading "Administrative expense," for example, both variable and fixed costs are lumped together.

Although an income statement prepared in the functional format may be useful for external reporting purposes, it has serious limitations when used for internal purposes. Internally, the manager needs cost data organized in a format that will facilitate planning, control, and decision-making. As we shall see in chapters ahead, these tasks are much easier when cost data are available in a fixed and variable format. The contribution approach to the income statement has been developed in response to these needs.

The Contribution Approach

Exhibit 5–14 uses a simple example to compare a contribution approach income statement to the traditional approach discussed in Chapter 2.

Notice that the contribution approach separates costs into fixed and variable categories, first deducting variable expenses from sales to obtain what is known as the *contribution margin.* The **contribution margin** is the amount remaining from sales revenues after variable expenses have been deducted. This amount *contributes* toward covering fixed expenses and then toward profits for the period.

The contribution approach to the income statement is used as an internal planning and decision-making tool. Its emphasis on costs by behavior facilitates cost-volume-profit analysis, such as we shall be doing in the next chapter. The approach is also very useful in appraising management performance, in segmented reporting of profit data, and in budgeting. Moreover, the contribution approach helps managers organize data pertinent to all kinds of special decisions such as product-line analysis, pricing, use of scarce resources, and make or buy analysis. All of these topics are covered in later chapters.

5–2

EXHIBIT 5–14

Comparison of the Contribution Income Statement with the Traditional Income Statement (the data are given)

Traditional Approach (costs organized by function)			Contribution Approach (costs organized by behavior)		
Sales		$12,000	Sales		$12,000
Less cost of goods sold		6,000*	Less variable expenses:		
Gross margin		6,000	Variable production	$2,000	
Less operating expenses:			Variable selling	600	
Selling	$3,100*		Variable administrative	400	3,000
Administrative	1,900*	5,000	Contribution margin		9,000
Net operating income		$ 1,000	Less fixed expenses:		
			Fixed production	4,000	
			Fixed selling	2,500	
			Fixed administrative	1,500	8,000
			Net operating income		$ 1,000

*Contains both variable and fixed expenses. This is the income statement for a manufacturing company; thus, when the income statement is placed in the contribution format, the "cost of goods sold" figure is divided between variable production costs and fixed production costs. If this were the income statement for a *merchandising* company (which simply purchases completed goods from a supplier), then the cost of goods sold would be *all* variable.

Summary

As we shall see in later chapters, the ability to predict how costs will respond to changes in activity is critical for making decisions, controlling operations, and evaluating performance. Three major classifications of costs were discussed in this chapter—variable, fixed, and mixed. Mixed costs consist of variable and fixed elements and can be expressed in equation form as $Y = a + bX$, where X is the activity, Y is the cost, a is the fixed cost element, and b is the variable cost per unit of activity.

Several methods are available to estimate the fixed and variable cost components of a mixed cost using past records of cost and activity. If the relation between cost and activity appears to be linear based on a scattergraph plot, then the variable and fixed components of the mixed cost can be estimated using the quick-and-dirty method, the high-low method, or the least-squares regression method. The quick-and-dirty method is based on drawing a straight line and then using the slope and the intercept of the straight line to estimate the variable and fixed cost components of the mixed cost. The high-low method implicitly draws a straight line through the points of lowest activity and highest activity. In most situations, the least-squares regression method is preferred to both the quick-and-dirty and high-low methods. Computer software is widely available for using the least-squares method. These software applications provide a variety of useful statistics along with estimates of the intercept (fixed cost) and slope (variable cost per unit). Nevertheless, even when least-squares regression is used, the data should be plotted to confirm that the relationship is really a straight line.

Managers use costs organized by behavior as a basis for many decisions. To facilitate this use, the income statement can be prepared in a contribution format. The contribution format income statement classifies costs by cost behavior (i.e., variable versus fixed) rather than by the functions of production, administration, and sales.

Review Problem 1: Cost Behavior

Neptune Rentals offers a boat rental service. Consider the following costs of the company over the relevant range of 5,000 to 8,000 hours of operating time for its boats:

	Hours of Operating Time			
	5,000	6,000	7,000	8,000
Total costs:				
Variable costs	$ 20,000	$?	$?	$?
Fixed costs	168,000	?	?	?
Total costs	$188,000	$?	$?	$?
Cost per hour:				
Variable cost	$?	$?	$?	$?
Fixed cost	?	?	?	?
Total cost per hour	$?	$?	$?	$?

Required:

Compute the missing amounts, assuming that cost behavior patterns remain unchanged within the relevant range of 5,000 to 8,000 hours.

Solution to Review Problem 1

The variable cost per hour can be computed as follows:

$$\$20{,}000 \div 5{,}000 \text{ hours} = \$4 \text{ per hour}$$

Therefore, in accordance with the behavior of variable and fixed costs, the missing amounts are as follows:

	Hours of Operating Time			
	5,000	6,000	7,000	8,000
Total costs:				
Variable costs	$ 20,000	$ 24,000	$ 28,000	$ 32,000
Fixed costs	168,000	168,000	168,000	168,000
Total costs	$188,000	$192,000	$196,000	$200,000
Cost per hour:				
Variable cost	$ 4.00	$ 4.00	$ 4.00	$ 4.00
Fixed cost	33.60	28.00	24.00	21.00
Total cost per hour	$ 37.60	$ 32.00	$ 28.00	$ 25.00

Observe that the total variable costs increase in proportion to the number of hours of operating time, but that these costs remain constant at $4 if expressed on a per hour basis.

In contrast, the total fixed costs do not change with changes in the level of activity. They remain constant at $168,000 within the relevant range. With increases in activity, however, the fixed cost decreases per hour, dropping from $33.60 per hour when the boats are operated 5,000 hours a period to only $21.00 per hour when the boats are operated 8,000 hours a period. *Because of this troublesome aspect of fixed costs, they are most easily (and most safely) dealt with on a total basis, rather than on a unit basis, in cost analysis work.*

Review Problem 2: High-Low Method

The administrator of Azalea Hills Hospital would like a cost formula linking the costs involved in admitting patients to the number of patients admitted during a month. The admitting department's costs and the number of patients admitted during the immediately preceding eight months are given in the following table:

Month	Number of Patients Admitted	Admitting Department Costs
May	1,800	$14,700
June	1,900	$15,200
July	1,700	$13,700
August	1,600	$14,000
September	1,500	$14,300
October	1,300	$13,100
November	1,100	$12,800
December	1,500	$14,600

Required:

1. Use the high-low method to establish the fixed and variable components of admitting costs.
2. Express the fixed and variable components of admitting costs as a cost formula in the linear equation form $Y = a + bX$.

Solution to Review Problem 2

1. The first step in the high-low method is to identify the periods of the lowest and highest activity. Those periods are November (1,100 patients admitted) and June (1,900 patients admitted).

   The second step is to compute the variable cost per unit using those two data points:

Month	Number of Patients Admitted	Admitting Department Costs
High activity level (June)	1,900	$15,200
Low activity level (November)	1,100	12,800
Change	800	$ 2,400

$$\text{Variable cost} = \frac{\text{Change in cost}}{\text{Change in activity}} = \frac{\$2{,}400}{800 \text{ patients admitted}} = \$3 \text{ per patient admitted}$$

The third step is to compute the fixed cost element by deducting the variable cost element from the total cost at either the high or low activity. In the computation below, the high point of activity is used:

$$\begin{aligned}\text{Fixed cost element} &= \text{Total cost} - \text{Variable cost element}\\ &= \$15{,}200 - (\$3 \text{ per patient admitted} \times 1{,}900 \text{ patients admitted})\\ &= \$9{,}500\end{aligned}$$

2. The cost formula expressed in the linear equation form is $Y = \$9{,}500 + \$3X$.

Glossary

Account analysis A method for analyzing cost behavior in which each account under consideration is classified as either variable or fixed based on the analyst's prior knowledge of how the cost in the account behaves. (p. 196)

Activity base A measure of whatever causes the incurrence of a variable cost. For example, the total cost of X-ray film in a hospital will increase as the number of X-rays taken increases. Therefore, the number of X-rays is an activity base that explains the total cost of X-ray film. (p. 185)

Committed fixed costs Those fixed costs that are difficult to adjust and that relate to investment in facilities, equipment, and basic organizational structure. (p. 190)

Contribution approach An income statement format that is geared to cost behavior in that costs are separated into variable and fixed categories rather than being separated according to the functions of production, sales, and administration. (p. 206)

Contribution margin The amount remaining from sales revenues after all variable expenses have been deducted. (p. 207)

Cost structure The relative proportion of fixed, variable, and mixed costs found within an organization. (p. 184)

Curvilinear costs A relationship between cost and activity that is a curve rather than a straight line. (p. 188)

Dependent variable A variable that responds to some causal factor; total cost is the dependent variable, as represented by the letter *Y,* in the equation $Y = a + bX$. (p. 199)

Discretionary fixed costs Those fixed costs that arise from annual decisions by management to spend in certain fixed cost areas, such as advertising and research. (p. 191)

Engineering approach A detailed analysis of cost behavior based on an industrial engineer's evaluation of the inputs that are required to carry out a particular activity and of the prices of those inputs. (p. 197)

High-low method A method of separating a mixed cost into its fixed and variable elements by analyzing the change in cost between the high and low activity levels. (p. 202)

Independent variable A variable that acts as a causal factor; activity is the independent variable, as represented by the letter *X,* in the equation $Y = a + bX$. (p. 199)

Least-squares regression method A method of separating a mixed cost into its fixed and variable elements by fitting a regression line that minimizes the sum of the squared errors. (p. 204)

Linear cost behavior Cost behavior is said to be linear whenever a straight line is a reasonable approximation for the relation between cost and activity. (p. 200)

Mixed cost A cost that contains both variable and fixed cost elements. (p. 194)

Multiple regression An analytical method required in those situations where variations in a dependent variable are caused by more than one factor. (p. 206)

R^2 A measure of goodness of fit in least-squares regression analysis. It is the percentage of the variation in the dependent variable that is explained by variation in the independent variable. (p. 205)

Relevant range The range of activity within which assumptions about variable and fixed cost behavior are valid. (p. 188)

Step-variable cost The cost of a resource (such as a maintenance worker) that is obtainable only in large chunks and that increases and decreases only in response to fairly wide changes in the activity level. (p. 188)

Appendix 5A: Least-Squares Regression Using Microsoft® Excel

LEARNING OBJECTIVE 5
Analyze a mixed cost using the least-squares regression method.

The least-squares regression method for estimating a linear relationship is based on the equation for a straight line:

$$Y = a + bX$$

As explained in the chapter, least-squares regression selects the values for the intercept a and the slope b that minimize the sum of the squared errors. The following formulas, which are derived in statistics and calculus texts, accomplish that objective:

$$b = \frac{n(\Sigma XY) - (\Sigma X)(\Sigma Y)}{n(\Sigma X^2) - (\Sigma X)^2}$$

$$a = \frac{(\Sigma Y) - b(\Sigma X)}{n}$$

where:

X = The level of activity (independent variable)

Y = The total mixed cost (dependent variable)

a = The total fixed cost (the vertical intercept of the line)

b = The variable cost per unit of activity (the slope of the line)

n = Number of observations

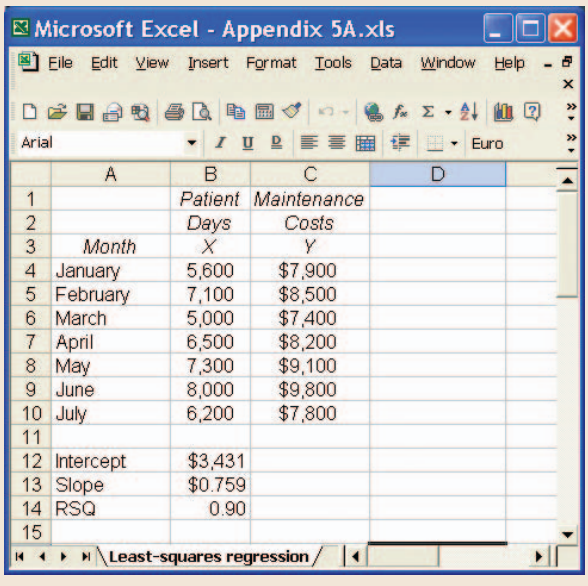
Σ = Sum across all n observations

Manually completing the calculations required by the formulas is tedious at best. Fortunately, statistical software packages are widely available that perform the calculations automatically. Spreadsheet software, such as Microsoft® Excel, can also be used to do least-squares regression—although it requires a little more work than using a specialized statistical application.

To illustrate how Excel can be used to calculate the intercept *a,* the slope *b,* and the R^2, we will use the Brentline Hospital data for maintenance costs on page 198. The worksheet in Exhibit 5A–1 contains the data and the calculations.

As you can see, the X values (the independent variable) have been entered in cells B4 through B10. The Y values (the dependent variable) have been entered in cells C4 through C10. The slope, intercept, and R^2 are computed using the Excel functions INTERCEPT, SLOPE, and RSQ. You must specify the range of cells for the Y values and for the X values. In the worksheet below, cell B12 contains the formula =INTERCEPT(C4:C10,B4:B10); cell B13 contains the formula =SLOPE(C4:C10,B4:B10); and cell B14 contains the formula =RSQ(C4:C10,B4:B10).

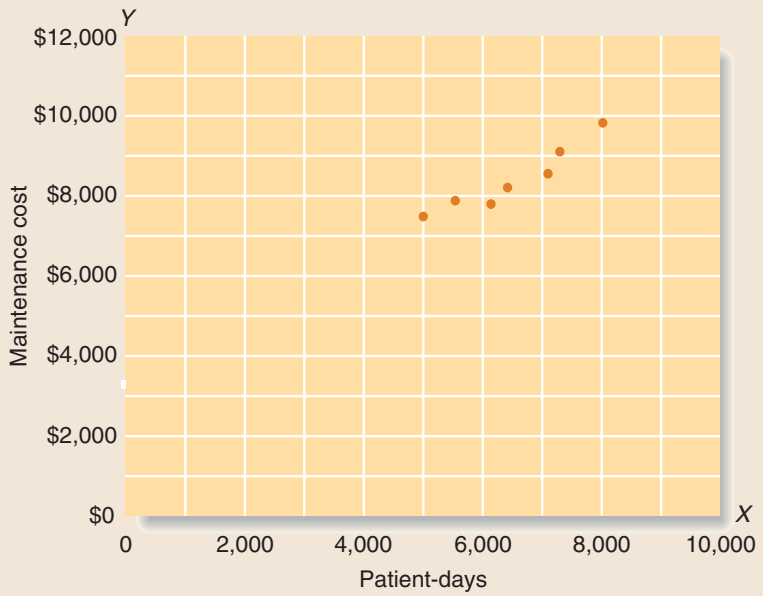
According to the calculations carried out by Excel, the fixed maintenance cost (the intercept) is $3,431 per month and the variable cost (the slope) is $0.759 per patient-day.



	A	B	C	D
1		*Patient*	*Maintenance*	
2		*Days*	*Costs*	
3	*Month*	*X*	*Y*	
4	January	5,600	$7,900	
5	February	7,100	$8,500	
6	March	5,000	$7,400	
7	April	6,500	$8,200	
8	May	7,300	$9,100	
9	June	8,000	$9,800	
10	July	6,200	$7,800	
11				
12	Intercept	$3,431		
13	Slope	$0.759		
14	RSQ	0.90		
15				

EXHIBIT 5A–1
The Least-Squares Regression Worksheet for Brentline Hospital

EXHIBIT 5A–2
A Scattergraph Plot of the Brentline Hospital Data



Therefore, the cost formula for maintenance cost is:

$$Y = a + bX$$

$$Y = \$3{,}431 + \$0.759X$$

Note that the R^2 (i.e., RSQ) is 0.90, which—as previously discussed—is quite good and indicates that 90% of the variation in maintenance costs is explained by the variation in patient-days.

Plotting the data is easy in Excel. Select the range of values that you would like to plot—in this case, cells B4:C10. Then select the Chart Wizard tool on the toolbar and make the appropriate choices in the various dialogue boxes that appear. When you are finished, you should have a scattergraph that looks like the plot in Exhibit 5A–2. Note that the relation between cost and activity is approximately linear, so it is reasonable to fit a straight line to the data as we have implicitly done with the least-squares regression.

Questions

5–1 Distinguish between (*a*) a variable cost, (*b*) a fixed cost, and (*c*) a mixed cost.

5–2 What effect does an increase in volume have on—

a. Unit fixed costs?
b. Unit variable costs?
c. Total fixed costs?
d. Total variable costs?

5–3 Define the following terms: (*a*) cost behavior and (*b*) relevant range.

5–4 What is meant by an *activity base* when dealing with variable costs? Give several examples of activity bases.

5–5 Distinguish between (*a*) a variable cost, (*b*) a mixed cost, and (*c*) a step-variable cost. Chart the three costs on a graph, with activity plotted horizontally and cost plotted vertically.

5–6 Managers often assume a strictly linear relationship between cost and volume. How can this practice be defended in light of the fact that many costs are curvilinear?

5–7 Distinguish between discretionary fixed costs and committed fixed costs.

5–8 Classify the following fixed costs as normally being either committed or discretionary:
a. Depreciation on buildings.
b. Advertising.
c. Research.
d. Long-term equipment leases.
e. Pension payments to the company's retirees.
f. Management development and training.

5–9 Does the concept of the relevant range apply to fixed costs? Explain.

5–10 What is the major disadvantage of the high-low method?

5–11 Give the general formula for a mixed cost. Which term represents the variable cost? The fixed cost?

5–12 What is meant by the term *least-squares regression?*

5–13 What is the difference between ordinary least-squares regression analysis and multiple regression analysis?

5–14 What is the difference between a contribution approach income statement and a traditional approach income statement?

5–15 What is the contribution margin?

Exercises

EXERCISE 5–1 Fixed and Variable Cost Behavior [LO1]

Espresso Express operates a number of espresso coffee stands in busy suburban malls. The fixed weekly expense of a coffee stand is $1,200 and the variable cost per cup of coffee served is $0.22.

Required:

1. Fill in the following table with your estimates of total costs and cost per cup of coffee at the indicated levels of activity for a coffee stand. Round off the cost of a cup of coffee to the nearest tenth of a cent.

	Cups of Coffee Served in a Week		
	2,000	2,100	2,200
Fixed cost	?	?	?
Variable cost	?	?	?
Total cost	?	?	?
Cost per cup of coffee served	?	?	?

2. Does the cost per cup of coffee served increase, decrease, or remain the same as the number of cups of coffee served in a week increases? Explain.

EXERCISE 5–2 High-Low Method; Scattergraph Analysis [LO2, LO3]

The following data relating to units shipped and total shipping expense have been assembled by Archer Company, a wholesaler of large, custom-built air-conditioning units for commercial buildings:

Month	Units Shipped	Total Shipping Expense
January	3	$1,800
February	6	$2,300
March	4	$1,700
April	5	$2,000
May	7	$2,300
June	8	$2,700
July	2	$1,200

Required:

1. Using the high-low method, estimate a cost formula for shipping expense.

2. The president of the company has no confidence in the high-low method and would like you to check out your results using a scattergraph.
   a. Prepare a scattergraph, using the data given above. Plot cost on the vertical axis and activity on the horizontal axis. Use a ruler to fit a straight line to your plotted points.
   b. Using your scattergraph, estimate the approximate variable cost per unit shipped and the approximate fixed cost per month with the quick-and-dirty method.
3. What factors, other than the number of units shipped, are likely to affect the company's total shipping expense? Explain.

EXERCISE 5–3 (Appendix 5A) Least-Square Regression [LO5]

Refer to the data for Archer Company in Exercise 5–2.

Required:

1. Using the least-squares regression method, estimate a cost formula for shipping expense.
2. If you also completed Exercise 5–2, prepare a simple table comparing the variable and fixed cost elements of shipping expense as computed under the quick-and-dirty scattergraph method, the high-low method, and the least-squares regression method.


EXERCISE 5–4 High-Low Method [LO3]

The Cheyenne Hotel in Big Sky, Montana, has accumulated records of the total electrical costs of the hotel and the number of occupancy-days over the last year. An occupancy-day represents a room rented out for one day. The hotel's business is highly seasonal, with peaks occurring during the ski season and in the summer.

Month	Occupancy-Days	Electrical Costs
January	1,736	$4,127
February	1,904	$4,207
March	2,356	$5,083
April	960	$2,857
May	360	$1,871
June	744	$2,696
July	2,108	$4,670
August	2,406	$5,148
September	840	$2,691
October	124	$1,588
November	720	$2,454
December	1,364	$3,529

Required:

1. Using the high-low method, estimate the fixed cost of electricity per month and the variable cost of electricity per occupancy-day. Round off the fixed cost to the nearest whole dollar and the variable cost to the nearest whole cent.
2. What other factors other than occupancy-days are likely to affect the variation in electrical costs from month to month?

EXERCISE 5–5 Contribution Format Income Statement [LO4]

The Alpine House, Inc., is a large retailer of winter sports equipment. An income statement for the company's Ski Department for a recent quarter is presented below:

THE ALPINE HOUSE, INC.
Income Statement—Ski Department
For the Quarter Ended March 31

Sales		$150,000
Less cost of goods sold		90,000
Gross margin		60,000
Less operating expenses:		
Selling expenses	$30,000	
Administrative expenses	10,000	40,000
Net operating income		$ 20,000

Skis sell, on the average, for $750 per pair. Variable selling expenses are $50 per pair of skis sold. The remaining selling expenses are fixed. The administrative expenses are 20% variable and 80% fixed. The company does not manufacture its own skis; it purchases them from a supplier for $450 per pair.

Required:

1. Prepare an income statement for the quarter using the contribution approach.
2. For every pair of skis sold during the quarter, what was the contribution toward covering fixed expenses and toward earning profits?

EXERCISE 5–6 Cost Behavior; Contribution Format Income Statement [LO1, LO4]

Harris Company manufactures and sells a single product. A partially completed schedule of the company's total and per unit costs over the relevant range of 30,000 to 50,000 units produced and sold annually is given below:

	Units Produced and Sold		
	30,000	40,000	50,000
Total costs:			
Variable costs	$180,000	?	?
Fixed costs	300,000	?	?
Total costs	$480,000	?	?
Cost per unit:			
Variable cost	?	?	?
Fixed cost	?	?	?
Total cost per unit	?	?	?

Required:

1. Complete the schedule of the company's total and unit costs above.
2. Assume that the company produces and sells 45,000 units during the year at a selling price of $16 per unit. Prepare a contribution format income statement for the year.

EXERCISE 5–7 High-Low Method; Predicting Cost [LO1, LO3]

St. Mark's Hospital contains 450 beds. The average occupancy rate is 80% per month. In other words, on average, 80% of the hospital's beds are occupied by patients. At this level of occupancy, the hospital's operating costs are $32 per occupied bed per day, assuming a 30-day month. This $32 figure contains both variable and fixed cost elements.

During June, the hospital's occupancy rate was only 60%. A total of $326,700 in operating cost was incurred during the month.

Required:

1. Using the high-low method, estimate:
   a. The variable cost per occupied bed on a daily basis.
   b. The total fixed operating costs per month.
2. Assume an occupancy rate of 70% per month. What amount of total operating cost would you expect the hospital to incur?

EXERCISE 5–8 High-Low Method; Predicting Cost [LO1, LO3]

The Lakeshore Hotel's guest-days of occupancy and custodial supplies expense over the last seven months were:

Month	Guest-Days of Occupancy	Custodial Supplies Expense
March	4,000	$7,500
April	6,500	$8,250
May	8,000	$10,500
June	10,500	$12,000
July	12,000	$13,500
August	9,000	$10,750
September	7,500	$9,750

Guest-days is a measure of the overall activity at the hotel. For example, a guest who stays at the hotel for three days is counted as three guest-days.

Required:

1. Using the high-low method, estimate a cost formula for custodial supplies expense.
2. Using the cost formula you derived above, what amount of custodial supplies expense would you expect to be incurred at an occupancy level of 11,000 guest-days?


EXERCISE 5–9 Scattergraph Analysis; High-Low Method [LO2, LO3]

Refer to the data for Lakeshore Hotel in Exercise 5–8.

Required:

1. Prepare a scattergraph using the data from Exercise 5–8. Plot cost on the vertical axis and activity on the horizontal axis. Using a ruler, fit a line to your plotted points.
2. Using the quick-and-dirty method, what is the approximate monthly fixed cost? The approximate variable cost per guest-day?
3. Scrutinize the points on your graph and explain why the high-low method would or would not yield an accurate cost formula in this situation.

EXERCISE 5–10 Scattergraph Analysis [LO2]

Oki Products, Ltd., has observed the following processing costs at various levels of activity over the last 15 months:

Month	Units Produced	Processing Cost
1	4,500	$38,000
2	11,000	$52,000
3	12,000	$56,000
4	5,500	$40,000
5	9,000	$47,000
6	10,500	$52,000
7	7,500	$44,000
8	5,000	$41,000
9	11,500	$52,000
10	6,000	$43,000
11	8,500	$48,000
12	10,000	$50,000
13	6,500	$44,000
14	9,500	$48,000
15	8,000	$46,000

Required:

1. Prepare a scattergraph using the above data. Plot cost on the vertical axis and activity on the horizontal axis. Fit a line to your plotted points using a ruler.
2. Using the quick-and-dirty method, what is the approximate monthly fixed cost? The approximate variable cost per unit processed? Show your computations.

EXERCISE 5–11 Cost Behavior; High-Low Method [LO1, LO3]

Hoi Chong Transport, Ltd., operates a fleet of delivery trucks in Singapore. The company has determined that if a truck is driven 105,000 kilometers during a year, the average operating cost is 11.4 cents per kilometer. If a truck is driven only 70,000 kilometers during a year, the average operating cost increases to 13.4 cents per kilometer. (The Singapore dollar is the currency used in Singapore.)

Required:

1. Using the high-low method, estimate the variable and fixed cost elements of the annual cost of truck operation.
2. Express the variable and fixed costs in the form $Y = a + bX$.
3. If a truck were driven 80,000 kilometers during a year, what total cost would you expect to be incurred?

EXERCISE 5–12 (Appendix 5A) Least-Squares Regression [LO1, LO5]

George Caloz & Frères, located in Grenchen, Switzerland, makes prestige high-end custom watches in small lots. The company has been in operation since 1856. One of the company's

products, a platinum diving watch, goes through an etching process. The company has observed etching costs as follows over the last six weeks:

Week	Units	Total Etching Cost
1	4	SFr18
2	3	17
3	8	25
4	6	20
5	7	24
6	2	16
	30	SFr120

The Swiss currency is the Swiss Franc, which is denoted by SFr.

For planning purposes, management would like to know the amount of variable etching cost per unit and the total fixed etching cost per week.

Required:

1. Using the least-squares regression method, estimate the variable and fixed elements of etching cost.
2. Express the cost data in (1) above in the form $Y = a + bX$.
3. If the company processes five units next week, what would be the expected total etching cost?

Problems

PROBLEM 5–13 Cost Behavior; High-Low Method; Contribution Format Income Statement [LO1, LO3, LO4]

eXcel

Morrisey & Brown, Ltd., of Sydney is a merchandising company that is the sole distributor of a product that is increasing in popularity among Australian consumers. The company's income statements for the three most recent months follow:

MORRISEY & BROWN, LTD.
Income Statements
For the Three Months Ending September 30

	July	August	September
Sales in units	4,000	4,500	5,000
Sales revenue	A$400,000	A$450,000	A$500,000
Less cost of goods sold	240,000	270,000	300,000
Gross margin	160,000	180,000	200,000
Less operating expenses:			
Advertising expense	21,000	21,000	21,000
Shipping expense	34,000	36,000	38,000
Salaries and commissions	78,000	84,000	90,000
Insurance expense	6,000	6,000	6,000
Depreciation expense	15,000	15,000	15,000
Total operating expenses	154,000	162,000	170,000
Net operating income	A$ 6,000	A$ 18,000	A$ 30,000

(Note: Morrisey & Brown, Ltd.'s Australian-formatted income statement has been recast in the format common in the United States. The Australian dollar is denoted here by A$.)

Required:

1. Identify each of the company's expenses (including cost of goods sold) as either variable, fixed, or mixed.
2. Using the high-low method, separate each mixed expense into variable and fixed elements. State the cost formula for each mixed expense.
3. Redo the company's income statement at the 5,000-unit level of activity using the contribution format.

PROBLEM 5–14 Contribution Format versus Traditional Income Statement [LO4]

Marwick's Pianos, Inc., purchases pianos from a large manufacturer and sells them at the retail level. The pianos cost, on the average, $2,450 each from the manufacturer. Marwick's Pianos, Inc., sells the pianos to its customers at an average price of $3,125 each. The selling and administrative costs that the company incurs in a typical month are presented below:

Costs	Cost Formula
Selling:	
Advertising	$700 per month
Sales salaries and commissions	$950 per month, plus 8% of sales
Delivery of pianos to customers	$30 per piano sold
Utilities	$350 per month
Depreciation of sales facilities	$800 per month
Administrative:	
Executive salaries	$2,500 per month
Insurance	$400 per month
Clerical	$1,000 per month, plus $20 per piano sold
Depreciation of office equipment	$300 per month

During August, Marwick's Pianos, Inc., sold and delivered 40 pianos.

Required:

1. Prepare an income statement for Marwick's Pianos, Inc., for August. Use the traditional format, with costs organized by function.
2. Redo (1) above, this time using the contribution format, with costs organized by behavior. Show costs and revenues on both a total and a per unit basis down through contribution margin.
3. Refer to the income statement you prepared in (2) above. Why might it be misleading to show the fixed costs on a per unit basis?

PROBLEM 5–15 (Appendix 5A) Least-Squares Regression Method Scattergraph; Cost Behavior [LO1, LO2, LO5]

Professor John Morton has just been appointed chairperson of the Finance Department at Westland University. In reviewing the department's cost records, Professor Morton has found the following total cost associated with Finance 101 over the last several terms:

Microsoft Excel - Problem 5-15 screen capture.xls

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	A	B	C	D
1	*Term*	*Number of Sections Offered*	*Total Cost*	
2	Fall, last year	4	$10,000	
3	Winter, last year	6	$14,000	
4	Summer, last year	2	$7,000	
5	Fall, this year	5	$13,000	
6	Winter, this year	3	$9,500	
7				

Sheet1 Sheet2 Sheet3

Professor Morton knows that there are some variable costs, such as amounts paid to graduate assistants, associated with the course. He would like to have the variable and fixed costs separated for planning purposes.

Required:

1. Using the least-squares regression method, estimate the variable cost per section and the total fixed cost per term for Finance 101.
2. Express the cost data derived in (1) above in the linear equation form $Y = a + bX$.
3. Assume that because of the small number of sections offered during the Winter Term this year, Professor Morton will have to offer eight sections of Finance 101 during the Fall Term. Compute the expected total cost for Finance 101. Can you see any problem with using the cost formula from (2) above to derive this total cost figure? Explain.
4. Prepare a scattergraph and fit a line to the plotted points using the cost formula expressed in (2) above.

PROBLEM 5–16 Identifying Cost Behavior Patterns [LO1]

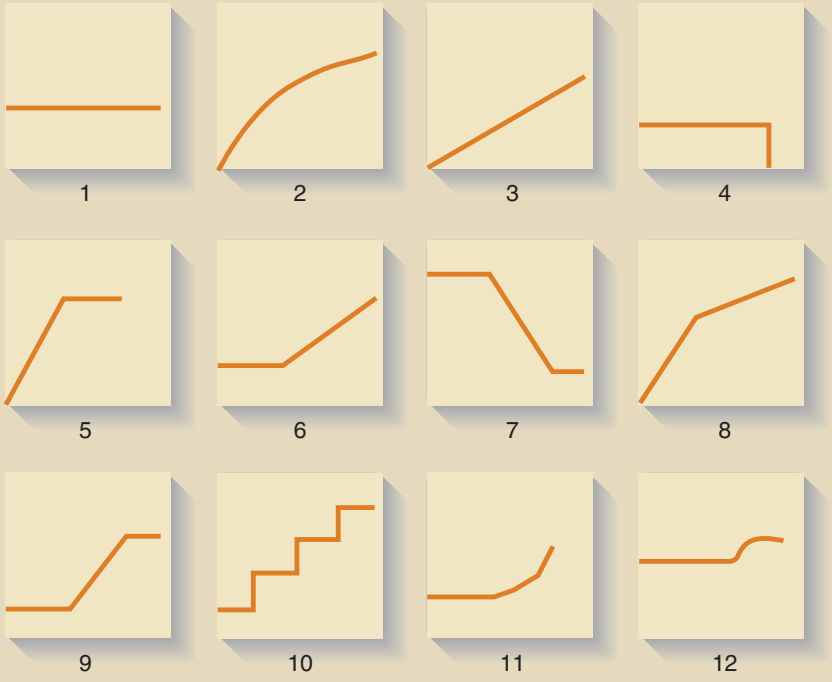
A number of graphs displaying cost behavior patterns are shown below. The vertical axis on each graph represents total cost, and the horizontal axis represents level of activity (volume).

Required:

1. For each of the following situations, identify the graph below that illustrates the cost behavior pattern involved. Any graph may be used more than once.
   a. Cost of raw materials used.
   b. Electricity bill—a flat fixed charge, plus a variable cost after a certain number of kilowatt-hours are used.
   c. City water bill, which is computed as follows:

First 1,000,000 gallons or less	$1,000 flat fee
Next 10,000 gallons	$0.003 per gallon used
Next 10,000 gallons	$0.006 per gallon used
Next 10,000 gallons	$0.009 per gallon used
Etc.	Etc.

   d. Depreciation of equipment, where the amount is computed by the straight-line method. When the depreciation rate was established, it was anticipated that the obsolescence factor would be greater than the wear and tear factor.
   e. Rent on a factory building donated by the city, where the agreement calls for a fixed fee payment unless 200,000 labor-hours or more are worked, in which case no rent need be paid.
   f. Salaries of maintenance workers, where one maintenance worker is needed for every 1,000 hours of machine-hours or less (that is, 0 to 1,000 hours requires one maintenance worker, 1,001 to 2,000 hours requires two maintenance workers, etc.)
   g. Cost of raw materials, where the cost starts at $7.50 per unit and then decreases by 5 cents per unit for each of the first 100 units purchased, after which it remains constant at $2.50 per unit.
   h. Rent on a factory building donated by the county, where the agreement calls for rent of $100,000 less $1 for each direct labor-hour worked in excess of 200,000 hours, but a minimum rental payment of $20,000 must be paid.
   i. Use of a machine under a lease, where a minimum charge of $1,000 is paid for up to 400 hours of machine time. After 400 hours of machine time, an additional charge of $2 per hour is paid up to a maximum charge of $2,000 per period.



2. How would a knowledge of cost behavior patterns such as those above be of help to a manager in analyzing the cost structure of his or her company?

(CPA, adapted)

PROBLEM 5–17 High-Low and Scattergraph Analysis [LO2, LO3]

Pleasant View Hospital of British Columbia has just hired a new chief administrator who is anxious to employ sound management and planning techniques in the business affairs of the hospital. Accordingly, she has directed her assistant to summarize the cost structure of the various departments so that data will be available for planning purposes.

The assistant is unsure how to classify the utilities costs in the Radiology Department since these costs do not exhibit either strictly variable or fixed cost behavior. Utilities costs are very high in the department due to a CAT scanner that draws a large amount of power and is kept running at all times. The scanner can't be turned off due to the long warm-up period required for its use. When the scanner is used to scan a patient, it consumes an additional burst of power. The assistant has accumulated the following data on utilities costs and use of the scanner since the first of the year.

Month	Number of Scans	Utilities Cost
January	60	$2,200
February	70	$2,600
March	90	$2,900
April	120	$3,300
May	100	$3,000
June	130	$3,600
July	150	$4,000
August	140	$3,600
September	110	$3,100
October	80	$2,500

The chief administrator has informed her assistant that the utilities cost is probably a mixed cost that will have to be broken down into its variable and fixed cost elements by use of a scattergraph. The assistant feels, however, that if an analysis of this type is necessary, then the high-low method should be used, since it is easier and quicker. The controller has suggested that there may be a better approach.

Required:

1. Using the high-low method, estimate a cost formula for utilities. Express the formula in the form $Y = a + bX$. (The variable rate should be stated in terms of cost per scan.)
2. Prepare a scattergraph using the data above. (The number of scans should be placed on the horizontal axis, and utilities cost should be placed on the vertical axis.) Fit a straight line to the plotted points using a ruler and estimate a cost formula for utilities using the quick-and-dirty method.

PROBLEM 5–18 (Appendix 5A) Least-Squares Regression Method [LO5]


Refer to the data for Pleasant View Hospital in Problem 5–17.

Required:

1. Using the least-squares regression method, estimate a cost formula for utilities. (Round the variable cost to two decimal places.)
2. Refer to the graph prepared in part (2) of Problem 5–17. Explain why in this case the high-low method would be the least accurate of the three methods in deriving a cost formula.

PROBLEM 5–19 Scattergraph Analysis [LO2]

Molina Company is a value-added computer resaler that specializes in providing services to small companies. The company owns and maintains several autos for use by the sales staff. All expenses of operating these autos have been entered into an Automobile Expense account on the company's books. Along with this record of expenses, the company has also kept a careful record of the number of miles the autos have been driven each month.

The company's records of miles driven and total auto expenses over the past 10 months are given below:

Month	Total Mileage (000)	Total Cost
January	4	$3,000
February	8	$3,700
March	7	$3,300
April	12	$4,000
May	6	$3,300
June	11	$3,900
July	14	$4,200
August	10	$3,600
September	13	$4,100
October	15	$4,400

Molina Company's president wants to know the cost of operating the fleet of cars in terms of the fixed monthly cost and the variable cost per mile driven.

Required:

1. Prepare a scattergraph using the data given above. Place cost on the vertical axis and activity (miles driven) on the horizontal axis. Using a ruler, fit a straight line to the plotted points.
2. Estimate the fixed cost per month and the variable cost per mile driven using the quick-and-dirty method.

PROBLEM 5–20 (Appendix 5A) Least-Squares Regression Method [LO5]

Refer to the data for Molina Company in Problem 5–19.

Required:

1. Using the least-squares regression method, estimate the variable and fixed cost elements associated with the company's fleet of autos. (Since the Total Mileage is in thousands of miles, the variable cost you compute will also be in thousands of miles. The cost can be left in this form, or you can convert it to a per mile basis by dividing the cost you get by 1,000.)
2. From the data in (1) above, express the cost formula for auto use in the linear equation form $Y = a + bX$.

PROBLEM 5–21 (Appendix 5A) Least-Squares Regression Analysis; Contribution Format Income Statement [LO4, LO5]

Milden Company has an exclusive franchise to purchase a product from the manufacturer and distribute it on the retail level. As an aid in planning, the company has decided to start using the contribution format income statement internally. To have data to prepare such a statement, the company has analyzed its expenses and developed the following cost formulas:


Cost	Cost Formula
Cost of good sold	$35 per unit sold
Advertising expense	$210,000 per quarter
Sales commissions	6% of sales
Shipping expense	?
Administrative salaries	$145,000 per quarter
Insurance expense	$9,000 per quarter
Depreciation expense	$76,000 per quarter

Management has concluded that shipping expense is a mixed cost, containing both variable and fixed cost elements. Units sold and the related shipping expense over the last eight quarters follow:

Quarter	Units Sold (000)	Shipping Expense
Year 1:		
First	10	$119,000
Second	16	$175,000
Third	18	$190,000
Fourth	15	$164,000

continued

Quarter	Units Sold (000)	Shipping Expense
Year 2:		
First	11	$130,000
Second	17	$185,000
Third	20	$210,000
Fourth	13	$147,000

Milden Company's president would like a cost formula derived for shipping expense so that a budgeted income statement using the contribution approach can be prepared for the next quarter.

Required:

1. Using the least-squares regression method, estimate a cost formula for shipping expense. (Since the Units Sold above are in thousands of units, the variable cost you compute will also be in thousands of units. It can be left in this form, or you can convert your variable cost to a per unit basis by dividing it by 1,000.)
2. In the first quarter of Year 3, the company plans to sell 12,000 units at a selling price of $100 per unit. Prepare a contribution format income statement for the quarter.

PROBLEM 5–22 High-Low Method; Cost of Goods Manufactured [LO1, LO3]

Amfac Company manufactures a single product. The company keeps careful records of manufacturing activities from which the following information has been extracted:

	Level of Activity	
	March–Low	June–High
Number of units produced	6,000	9,000
Cost of goods manufactured	$168,000	$257,000
Work in process inventory, beginning	$9,000	$32,000
Work in process inventory, ending	$15,000	$21,000
Direct materials cost per unit	$6	$6
Direct labor cost per unit	$10	$10
Manufacturing overhead cost, total	?	?

The company's manufacturing overhead cost consists of both variable and fixed cost elements. To have data available for planning, management wants to determine how much of the overhead cost is variable with units produced and how much of it is fixed per month.

Required:

1. For both March and June, estimate the amount of manufacturing overhead cost added to production. The company had no under- or overapplied overhead in either month. (Hint: A useful way to proceed might be to construct a schedule of cost of goods manufactured.)
2. Using the high-low method, estimate a cost formula for manufacturing overhead. Express the variable portion of the formula in terms of a variable rate per unit of product.
3. If 7,000 units are produced during a month, what would be the cost of goods manufactured? (Assume that work in process inventories do not change and that there is no under- or overapplied overhead cost for the month.)

PROBLEM 5–23 High-Low Method; Predicting Cost [LO1, LO3]

Sawaya Co., Ltd., of Japan is a manufacturing company whose total factory overhead costs fluctuate considerably from year to year according to increases and decreases in the number of direct labor-hours worked in the factory. Total factory overhead costs (in Japanese yen, denoted ¥) at high and low levels of activity for recent years are given below:

	Level of Activity	
	Low	High
Direct labor-hours	50,000	75,000
Total factory overhead costs	¥14,250,000	¥17,625,000

The factory overhead costs above consist of indirect materials, rent, and maintenance. The company has analyzed these costs at the 50,000-hour level of activity as follows:

Indirect materials (variable)	¥5,000,000
Rent (fixed)	6,000,000
Maintenance (mixed)	3,250,000
Total factory overhead costs	¥14,250,000

To have data available for planning, the company wants to break down the maintenance cost into its variable and fixed cost elements.

Required:

1. Estimate how much of the ¥17,625,000 factory overhead cost at the high level of activity consists of maintenance cost. (Hint: To do this, it may be helpful to first determine how much of the ¥17,625,000 consists of indirect materials and rent. Think about the behavior of variable and fixed costs!)
2. Using the high-low method, estimate a cost formula for maintenance.
3. What total factory overhead costs would you expect the company to incur at an operating level of 70,000 direct labor-hours?

PROBLEM 5–24 High-Low Method; Predicting Cost [LO1, LO3]

Nova Company's total overhead costs at various levels of activity are presented below:

Month	Machine-Hours	Total Overhead Costs
April	70,000	$198,000
May	60,000	$174,000
June	80,000	$222,000
July	90,000	$246,000

Assume that the total overhead costs above consist of utilities, supervisory salaries, and maintenance. The breakdown of these costs at the 60,000 machine-hour level of activity is:

Utilities (variable)	$ 48,000
Supervisory salaries (fixed)	21,000
Maintenance (mixed)	105,000
Total overhead costs	$174,000

Nova Company's management wants to break down the maintenance cost into its variable and fixed cost elements.

Required:

1. Estimate how much of the $246,000 of overhead cost in July was maintenance cost. (Hint: to do this, it may be helpful to first determine how much of the $246,000 consisted of utilities and supervisory salaries. Think about the behavior of variable and fixed costs!)
2. Using the high-low method, estimate a cost formula for maintenance.
3. Express the company's *total* overhead costs in the linear equation form $Y = a + bX$.
4. What *total* overhead costs would you expect to be incurred at an operating activity level of 75,000 machine-hours?

Cases

CASE 5–25 (Appendix 5A) Analysis of Mixed Costs, Job-Order Costing, and Activity-Based Costing [LO1, LO2, LO5]

Hokuriku-Seika Co., Ltd., of Yokohama, Japan, is a subcontractor to local manufacturing companies. The company specializes in precision metal cutting using focused high-pressure water jets and

high-energy lasers. The company has a traditional job-order costing system in which direct labor and direct materials costs are assigned directly to jobs, but factory overhead is applied to jobs using a predetermined overhead rate with direct labor-hours as the activity base. Management uses this job cost data for valuing cost of goods sold and inventories for external reports. For internal decision making, management has largely ignored this cost data since direct labor costs are basically fixed and management believes overhead costs actually have little to do with direct labor-hours. Recently, management has become interested in activity-based costing (ABC) as a way of estimating job costs and other costs for decision-making purposes.

Management assembled a cross-functional team to design a prototype ABC system. Electrical costs were among the first factory overhead costs investigated by the team. Electricity is used to provide light, to power equipment, and to heat the building in the winter and cool it in the summer. The ABC team proposed allocating electrical costs to jobs based on machine-hours since running the machines consumes significant amounts of electricity. Data assembled by the team concerning actual direct labor-hours, machine-hours, and electrical costs over a recent eight-week period appear below. (The Japanese currency is the yen, which is denoted by ¥.)

	Direct Labor-Hours	Machine-Hours	Electrical Costs
Week 1	8,920	7,200	¥ 77,100
Week 2	8,810	8,200	84,400
Week 3	8,950	8,700	80,400
Week 4	8,990	7,200	75,500
Week 5	8,840	7,400	81,100
Week 6	8,890	8,800	83,300
Week 7	8,950	6,400	79,200
Week 8	8,990	7,700	85,500
Total	71,340	61,600	¥646,500

To help assess the effect of the proposed change to machine-hours as the allocation base, the eight-week totals were converted to annual figures by multiplying them by six.

	Direct Labor-Hours	Machine-Hours	Electrical Costs
Estimated annual total (eight-week total above × 6)	428,040	369,600	¥3,879,000

Required:

1. Assume that the estimated annual totals from the above table are used to compute the company's predetermined overhead rate. What would be the predetermined overhead rate for electrical costs if the allocation base is direct labor-hours? Machine-hours?
2. Hokuriku-Seika Co. intends to bid on a job for a shipyard that would require 350 direct labor-hours and 270 machine-hours. How much electrical cost would be charged to this job using the predetermined overhead rate computed in (1) above if the allocation base is direct labor-hours? Machine-hours?
3. Prepare a scattergraph in which you plot direct labor-hours on the horizontal axis and electrical costs on the vertical axis. Prepare another scattergraph in which you plot machine-hours on the horizontal axis and electrical costs on the vertical axis. Do you agree with the ABC team that machine-hours is a better allocation base for electrical costs than direct labor-hours? Why?
4. Using machine-hours as the measure of activity, estimate the fixed and variable components of electrical costs using least-squares regression.
5. How much electrical cost do you think would actually be caused by the shipyard job in (2) above? Explain.
6. What factors, apart from direct labor-hours and machine-hours, are likely to affect consumption of electrical power in the company?

CASE 5–26 Scattergraph Analysis; Selection of an Activity Base [LO2]

Angora Wraps of Pendleton, Oregon, makes fine sweaters out of pure angora wool. The business is seasonal, with the largest demand during the fall, the winter, and Christmas holidays. The company must ramp up production each summer to meet estimated demand.

The company has been analyzing its costs to determine which costs are fixed and variable for planning purposes. Below are data for the company's activity and direct labor costs over the last year.

Month	Thousands of Units Produced	Number of Paid Days	Direct Labor Cost
January	98	20	$14,162
February	76	20	$12,994
March	75	21	$15,184
April	80	22	$15,038
May	85	22	$15,768
June	102	21	$15,330
July	52	19	$13,724
August	136	21	$14,162
September	138	22	$15,476
October	132	23	$15,476
November	86	18	$12,972
December	56	21	$14,074

The number of workdays varies from month to month due to the number of weekdays, holidays, and days of vacation in the month. The paid days include paid vacations (in July) and paid holidays (in November and December). The number of units produced in a month varies depending on demand and the number of workdays in the month.

The company has eight workers who are classified as direct labor.

Required:

1. Plot the direct labor cost and units produced on a scattergraph. (Place cost on the vertical axis and units produced on the horizontal axis.)
2. Plot the direct labor cost and number of paid days on a scattergraph. (Place cost on the vertical axis and the number of paid days on the horizontal axis.)
3. Which measure of activity—number of units produced or paid days—should be used as the activity base for explaining direct labor cost? Explain

CASE 5–27 Analysis of Mixed Costs in a Pricing Decision [LO1 and LO2, LO3, or LO5]


Maria Chavez owns a catering company that serves food and beverages at parties and business functions. Chavez's business is seasonal, with a heavy schedule during the summer months and holidays and a lighter schedule at other times.

One of the major events Chavez's customers request is a cocktail party. She offers a standard cocktail party and has estimated the cost per guest as follows:

Food and beverages	$15.00
Labor (0.5 hrs. @ $10.00/hr.)	5.00
Overhead (0.5 hrs. @ $13.98/hr.)	6.99
Total cost per guest	$26.99

The standard cocktail party lasts three hours and Chavez hires one worker for every six guests, so that works out to one-half hour of labor per guest. These workers are hired only as needed and are paid only for the hours they actually work.

When bidding on cocktail parties, Chavez adds a 15% markup to yield a price of about $31 per guest. She is confident about her estimates of the costs of food and beverages and labor but is not as comfortable with the estimate of overhead cost. The $13.98 overhead cost per labor hour was determined by dividing total overhead expenses for the last 12 months by total labor hours for the same period. Monthly data concerning overhead costs and labor-hours follow:

Month	Labor-Hours	Overhead Expenses
January	2,500	$ 55,000
February	2,800	59,000
March	3,000	60,000
April	4,200	64,000
May	4,500	67,000
June	5,500	71,000
July	6,500	74,000
August	7,500	77,000
September	7,000	75,000
October	4,500	68,000
November	3,100	62,000
December	6,500	73,000
Total	57,600	$805,000

Chavez has received a request to bid on a 180-guest fund-raising cocktail party to be given next month by an important local charity. (The party would last the usual three hours.) She would like to win this contract because the guest list for this charity event includes many prominent individuals that she would like to land as future clients. Maria is confident that these potential customers would be favorably impressed by her company's services at the charity event.

Required:

1. Estimate the contribution to profit of a standard 180-guest cocktail party if Chavez charges her usual price of $31 per guest. (In other words, by how much would her overall profit increase?)
2. How low could Chavez bid for the charity event in terms of a price per guest and still not lose money on the event itself?
3. The individual who is organizing the charity's fund-raising event has indicated that he has already received a bid under $30 from another catering company. Do you think Chavez should bid below her normal $31 per guest price for the charity event? Why or why not?

(CMA, adapted)

CASE 5–28 (Appendix 5A) Mixed Cost Analysis Using Three Methods [LO2, LO3, LO5]

The Ramon Company manufactures a wide range of products at several locations. The Franklin plant, which manufactures electrical components, has been experiencing difficulties with fluctuating monthly overhead costs. These fluctuations have made it difficult to estimate the level of overhead that will be incurred for a month.

Management wants to be able to estimate overhead costs accurately to better plan its operational and financial needs. A trade publication indicates that for companies manufacturing electrical components, overhead tends to vary with direct labor-hours, but may contain both fixed and variable elements.

A member of the accounting staff has suggested that a good starting place for determining the cost behavior of overhead costs would be an analysis of historical data. The methods that have been proposed for determining the cost behavior pattern include high-low, scattergraph, and least-squares regression. Data on direct labor-hours and overhead costs have been collected for the past two years. The raw data are as follows:

	Last Year		This Year	
Month	Direct Labor-Hours	Overhead Costs	Direct Labor-Hours	Overhead Costs
January	20,000	$84,000	21,000	$86,000
February	25,000	$99,000	24,000	$93,000
March	22,000	$89,500	23,000	$93,000
April	23,000	$90,000	22,000	$87,000
May	20,000	$81,500	20,000	$80,000
June	19,000	$75,500	18,000	$76,500

continued

Month	Last Year: Direct Labor-Hours	Last Year: Overhead Costs	This Year: Direct Labor-Hours	This Year: Overhead Costs
July	14,000	$70,500	12,000	$67,500
August	10,000	$64,500	13,000	$71,000
September	12,000	$69,000	15,000	$73,500
October	17,000	$75,000	17,000	$72,500
November	16,000	$71,500	15,000	$71,000
December	19,000	$78,000	18,000	$75,000

All equipment in the Franklin plant is leased under an arrangement calling for a flat fee up to 19,500 direct labor-hours, after which lease charges are assessed on an hourly basis. Lease expense is a major element of overhead cost.

Required:

1. Using the high-low method, estimate the cost formula for overhead in the Franklin plant.
2. Repeat (1) above, this time using the least-squares regression method.
3. Prepare a scattergraph using all of the data for the two-year period. Fit a straight line or lines to the plotted points using a ruler. In this part it is not necessary to compute the fixed and variable cost elements.
4. Assume that the Franklin plant works 22,500 direct labor-hours during a month. Estimate the expected overhead cost for the month using the cost formulas developed above with:
   a. The high-low method.
   b. The least-squares regression method.
   c. The scattergraph method [read the expected costs directly off the graph prepared in (3) above].
5. Of the three proposed methods, explain which one the Ramon Company should use to estimate monthly overhead costs in the Franklin plant. Explain why the other methods are less m desirable.

(CMA, adapted)

Group and Internet Exercises

GROUP EXERCISE 5–29 Variable and Fixed Costs in Practice

Form a team to investigate how an organization in your area handles variable and fixed costs. It may be in any industry and can be a business, a not-for-profit organization, or a part of the government. Research the organization on the Web and in periodicals to learn what the organization does and how it has performed financially. Make an appointment to meet with the controller, chief financial officer, or with another top manager who is familiar with the financial side of the organization. After meeting with that individual, write a memo in which you discuss the following issues.

Required:

1. Does the organization distinguish between variable and fixed costs in planning and controlling operations? If not, why not?
2. If the organization does distinguish between variable and fixed costs, how are variable and fixed costs estimated? What activity bases are used? How are these activity bases selected? What method does the company use for estimating the variable cost per unit of activity? How often are these estimates made? Does the company prepare scattergraphs of past cost and activity data?
3. If the organization does distinguish between variable and fixed costs, how does this help managers in planning and controlling operations?

INTERNET EXERCISE 5–30

As you know, the World Wide Web is a medium that is constantly evolving. Sites come and go, and change without notice. To enable the periodic updating of site addresses, this problem has been posted to the textbook website (www.mhhe.com/garrison11e). After accessing the site, enter the Student Center and select this chapter. Select and complete the Internet Exercise.