Chapter 4

Techniques for Estimating Fixed and Variable Costs

YOU NOW UNDERSTAND THAT MOST accounting systems, such as the one at Hercules, are set up to comply with Generally Accepted Accounting Principles (GAAP). Unfortunately, these systems combine controllable costs and benefits with non-controllable costs and benefits. Thus, you need to modify Hercules' system to accurately estimate the profit from offering yoga. How can you accomplish this task? More generally, how do managers modify their GAAP-based accounting systems to identify controllable costs and make effective internal decisions?

APPLYING THE DECISION FRAMEWORK

What Is the Problem?	Hercules is losing membership to the competition, Apex Health & Fitness. This erosion in membership adversely affects Tom and Lynda's goal of maximizing the profit from their health club.
What Are the Options?	(1) Offer yoga; (2) do not offer yoga.
What Are the Costs and Benefits?	We will use Hercules' accounting system to estimate the revenues and costs associated with offering yoga.
Make the Decision!	Offer yoga if it increases Hercules' profit. Otherwise, consider other options, such as karate.

Thomas Northcut/Getty Images

Tom and Lynda could use several techniques to estimate the costs and benefits from offering yoga.

LEARNING OBJECTIVES

After studying this chapter, you will be able to:

1. Prepare a contribution margin statement.
2. Use the account classification method to identify fixed and variable costs.
3. Compute fixed and variable costs using the high-low method.
4. Perform regression analysis to estimate fixed and variable costs.
5. Construct segmented contribution margin statements.

In this chapter, you will learn how to use available financial data to estimate the profit of short-term decision options, such as the decision to offer yoga. In the short-term, many costs are fixed and non-controllable. Examples include costs relating to property, plant, and equipment. In contrast, most variable costs are controllable. Accordingly, separating variable costs from fixed costs is a useful step for estimating controllable costs.

We begin this chapter by introducing the contribution margin, a concept central to short-term decisions. We then describe three techniques firms use to estimate variable and fixed costs, and therefore contribution margins, using available financial data from the systems we studied in Chapter 3. We illustrate how these techniques help firms make effective decisions. Finally, we show you how to construct segmented contribution margin statements, corresponding to individual products, customers, or geographical regions.

CHAPTER CONNECTIONS

In Chapter 5, we discuss cost-volume-profit analysis, a short-term planning tool that helps managers understand how revenues, costs, and profit vary as the volume of business varies.

Contribution Margin Statement

LEARNING OBJECTIVE 1

Prepare a contribution margin statement.

In Exhibit 4.1, we reproduce Hercules' income statement for the most recent month of operations.

Recall that Tom and Lynda use this statement for external reporting. The statement groups costs by business function. Such a functional classification is not helpful for decision making because it does not separate costs by their variability. For example, the item "costs of providing programs and services" contains variable costs such as supplies. But it also contains fixed costs such as equipment depreciation. Thus, Tom and Lynda cannot use this statement to answer questions such as "how much will costs increase if we add another 50 members?" because adding members will increase only the variable costs. The fixed costs stay the same, unless additional equipment or instructors are necessary to support the increased membership, in which case there will be a "step" increase in the fixed costs. The *contribution margin statement*, which we consider next, helps answer such questions.

ORGANIZING INFORMATION TO HELP MAKE DECISIONS

Exhibit 4.2 presents Hercules' **contribution margin statement**. This statement reorganizes the data in Exhibit 4.1, grouping costs by their variability. That is, it reports variable and fixed costs as separate line items.

The term **contribution margin** denotes *the amount that remains after subtracting variable costs from revenues.* It is the amount that *contributes* toward recovering fixed costs and earning a profit. Like revenues and variable costs, the contribution margin changes proportionately with activity volume.

The contribution margin statement is well suited to evaluate short-term decision options. As you learned in Chapter 2, an essential aspect of decision making in the short term is that the decision maker cannot change capacity. In other words, capacity costs are not controllable in the short-term. The contribution margin statement captures this aspect by separating out fixed costs, which relate to the cost of

Exhibit 4.1 *Hercules Health Club: Income Statement for the Most Recent Month*

Revenues	$80,000
Costs of providing programs and services	55,000
Gross margin	$25,000
Management salaries, marketing, and administration	15,000
Profit before taxes	$10,000

CHAPTER CONNECTIONS

Hercules reports the same profit in Exhibit 4.1 and Exhibit 4.2. This is because, as a service firm, Hercules has no inventory of finished goods. In Chapter 9, we show how inventories could cause the reported income under GAAP to differ from income reported under the contribution margin statement.

Exhibit 4.2 *Hercules Health Club: Contribution Margin Statement for the Most Recent Month*

Number of Members	1,000
Revenues	$80,000
Variable costs	30,000
Contribution margin	$50,000
Fixed costs	40,000
Profit before taxes	$10,000

capacity resources. Moreover, by calculating the contribution margin, the statement focuses attention on revenues and variable costs, items usually controllable in the short-term.

Now that you understand the features of a contribution margin statement, let us turn to two natural questions: *How do we use the information in Exhibit 4.2 to make good decisions? Second, how do we modify the traditional income statement in Exhibit 4.1 to prepare the statement in Exhibit 4.2?*

USING THE CONTRIBUTION MARGIN STATEMENT

Consider Tom and Lynda's problem. They hope that offering yoga will increase Hercules' membership relative to the status quo. Increasing membership will bring in more revenues, but it will increase Hercules' variable costs as well. Offering yoga also might add to fixed costs such as instructor salaries and advertising. The value of offering yoga then is the change in revenues less the change in costs.

The contribution margin statement helps us identify these components of value. Consider revenues first. Assume Tom and Lynda expect to gain 30 new members from offering yoga. From Exhibit 4.2, we know that total revenues are $80,000 and the total membership is 1,000. Thus, the monthly revenue per member is $80. Using this estimate, we calculate the expected additional revenues as 30 new members × $80 = $2,400 per month, or $28,800 per year.

Next, estimate the change in costs. The contribution margin statement separates fixed and variable costs, alerting us to differences in cost behavior. It presents total costs as the sum of (1) fixed costs and (2) the variable cost per member times the number of members. Thus, we can estimate the cost of a decision option as the sum of (1) the change in fixed costs and (2) the unit variable cost times the change in activity volume.

In most cases, we can easily identify the change in fixed costs arising from a decision. For example, Hercules needs a yoga instructor for the yoga class. The yoga instructor's annual salary of $10,000 is a fixed cost that we can trace to the

Check It! Exercise #1

Why does your estimate of the controllable fixed costs of offering yoga ignore what Tom and Lynda pay for rent? Suppose that offering yoga would permit Hercules to terminate its contract with the Pilates instructor. How would this affect the costs and benefits of offering yoga?

Solution at end of chapter.

decision to offer the yoga class. In addition, Tom and Lynda plan to spend $2,000 annually advertising the yoga program. This expenditure also increases the club's fixed costs. Combining the $10,000 in salary and the $2,000 in advertising, we can estimate the additional fixed costs connected with the yoga class at $12,000 per year.

Going back to Exhibit 4.2, we can divide the total variable costs of $30,000 by the 1,000 members to estimate the variable cost per member at $30. Multiplying this $30 variable cost per member by the 30 new members shows that variable costs would increase by $900 per month, or $10,800 annually.

Collecting annual revenues and costs, we have:

Increase in revenues	$28,800
− Increase in variable costs	10,800
− Increase in fixed costs	12,000
= Increase in profit	$6,000

We also could compute the increase in profit directly by using the contribution margin per member. Again using Exhibit 4.2, dividing the $50,000 contribution margin by the 1,000 members shows that each member contributes $50 per month toward fixed costs and profit. (We can confirm this by subtracting $30 in variable costs per member from $80 in revenue per member.) Adding 30 members would increase annual contribution by 30 members × $50 per member × 12 months = $18,000. Finally, subtracting from this amount the increase of $12,000 in fixed costs yields an increase in profit of $6,000.

ESTIMATING COST STRUCTURE

The above analysis shows how the contribution margin statement can help us make effective decisions. But, to construct such statements, we must first estimate a company's **cost structure** or, in other words, the variable and fixed portions of a company's costs.

Most firms rely on historical data to estimate their cost structure, assuming that past relations will continue into the future. As Exhibit 4.3 indicates, a systematic approach begins by examining historical data to understand the extent to which costs have varied with changes in activity levels in the past. Scatter plots, such as those illustrated in Exhibit 4.4, help in inspecting the historical data. The horizontal axis of the scatter plot represents the activity level or volume (such as membership in the Hercules example), and the vertical axis reflects the total cost. Each dot in the plot reflects the total cost incurred in a prior period for a certain activity volume.

The scatter plot in panel A of Exhibit 4.4 reflects no clear pattern. In panel B, we see that total cost appears to stay more or less the same for different activity volumes, indicating that a significant proportion of total cost is likely fixed. In contrast, panel C indicates a linear relationship between the total cost and activity volume.

Exhibit 4.3 *Methods for Using Historical Data for Estimating the Relation between Activities and Costs*

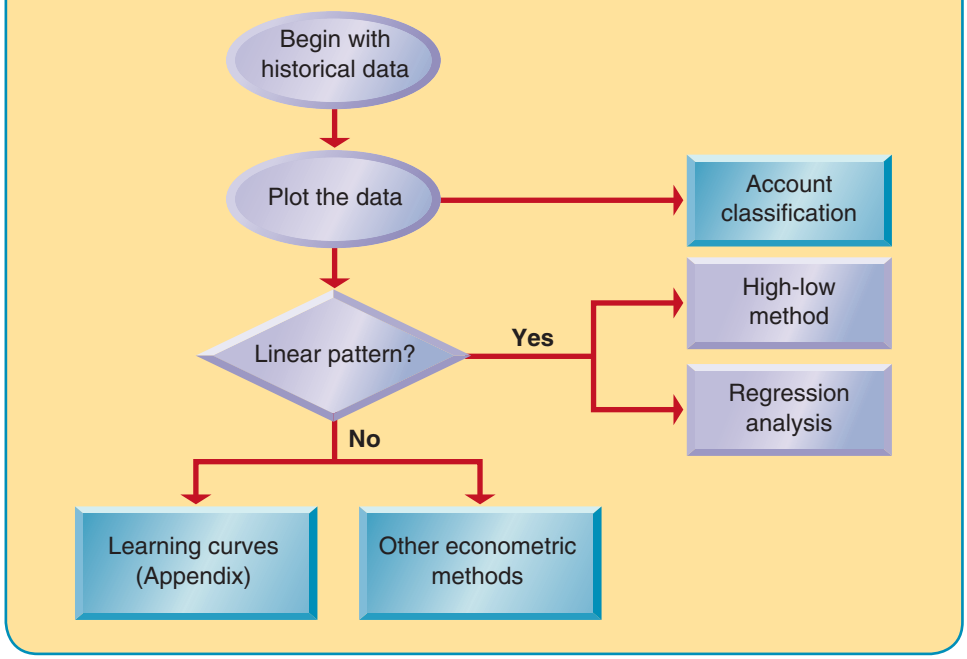
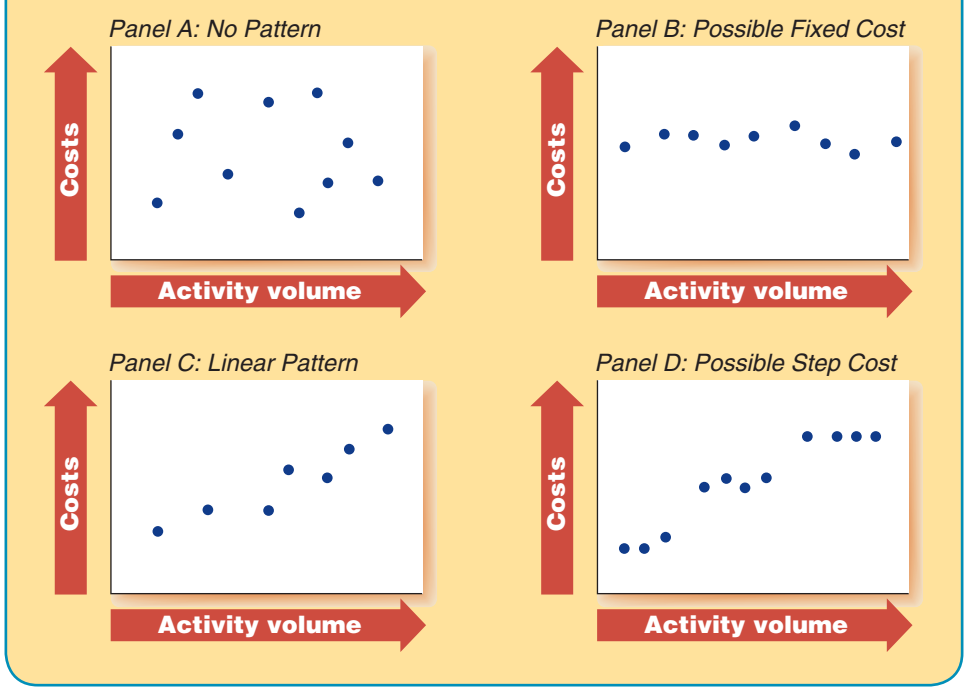


Exhibit 4.4 *Scatter Plots Reveal Relations between Costs and Activities*



Finally, in panel D, total cost appears to be increasing in small steps as activity volume increases.

Graphing the data helps us determine the appropriate technique to use to estimate fixed and variable costs. We also obtain a visual confirmation of the relation between the chosen activity and the cost, helping us select a suitable driver. Finally, scatter plots often reveal a few data points that do not appear to conform to the general pattern emerging from other data points. Such "outliers" or extreme observations are typically the result of recording errors or unusual activities in a specific period. We usually eliminate such observations from our analyses.

Based on our scatter plot, we determine whether a linear function adequately describes our data. If the answer is yes, as is often the case, we then have to estimate the parameters of the linear equation. In the next section, we discuss three techniques that firms use to estimate cost structure: account classification, high-low, and regression analysis (see Exhibit 4.3).

Account Classification Method

LEARNING OBJECTIVE 2

Use the account classification method to identify fixed and variable costs.

The **account classification method** involves systematically categorizing a company's cost accounts as fixed or variable. We then estimate the change in variable costs as follows:

1. Sum the costs classified as variable to obtain the total variable costs for the most recent period.
2. Divide the amount in (1) by the volume of activity for the corresponding period to estimate the unit variable cost (e.g., variable cost per member).
3. Multiply (2) by the change in activity to estimate the total controllable variable cost.

We obtain the data for the account classification method from accounting records that list the expenses for each account. Exhibit 4.5 presents an expanded version of Hercules' GAAP income statement from Exhibit 4.1.

Based on Exhibit 4.5, and a detailed analysis of costs in individual account headings, we classify four of Hercules' cost items as variable: (1) supplies; (2) equipment maintenance and replacement parts; (3) laundry and janitorial services; and (4) other expenses (membership badges and giveaways). We expect these costs to vary proportionally with the number of members. The other costs appear fixed in the short term.

We can then construct the contribution margin statement shown in Exhibit 4.6. This statement is naturally a more detailed version of Exhibit 4.2.

For each line item in Exhibit 4.6, we calculate the change in cost from introducing yoga. As we learned earlier, Tom and Lynda believe that revenues and all variable costs will increase proportionately with the addition of 30 new members. Fixed costs would increase by $12,000 per year. Thus, as before, we estimate the change in annual profit as 30 members × [$80 in fees per member per month − $30 variable cost per member per month] × 12 months − $12,000 = $6,000.

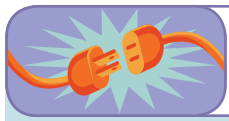
If needed, we can refine this estimate by using a separate cost driver for each item rather than use the number of members as the only driver. We also could include features such as steps in costs. (In our example, we ignore these refinements for simplicity.)

Exhibit 4.5 *Hercules Health Club: Income Statement for the Most Recent Month*

Membership revenues		$80,000
Costs of providing programs and services		
Supplies (sports supplies, bath supplies)	$8,000	
Equipment maintenance and replacement parts	12,000	
Salaries for physical instructors and coaches	9,000	
Laundry and janitorial services	6,000	
Staff salaries (for member services)	5,500	
Space rental for the club	8,500	
Renting the parking space for the club	2,000	
Other expenses (membership badges and giveaways)	4,000	
Total		$55,000
Gross margin		$25,000
Management, marketing, and administration		
Management salaries	8,500	
Staff salaries (for administration)	4,500	
Marketing costs	2,000	
Total		15,000
Profit before taxes		$10,000

Exhibit 4.6 *Hercules Health Club: Contribution Margin Statement for the Most Recent Month*

Membership Revenues		$80,000
Variable Costs		
Supplies (sports supplies, bath supplies)	$8,000	
Equipment maintenance and replacement parts	12,000	
Laundry and janitorial services	6,000	
Other expenses (membership badges and giveaways)	4,000	
Total variable costs		30,000
Contribution Margin		$50,000
Fixed Costs		
Salaries for physical instructors and coaches	9,000	
Staff salaries (for member services)	5,500	
Space rental for the club	8,500	
Renting the parking space for the club	2,000	
Management salaries	8,500	
Staff salaries (for administration)	4,500	
Marketing costs	2,000	
Total fixed costs		40,000
Profit before taxes		$10,000



Connecting to Practice

GRANTS FOR RESEARCH

Many faculty members support their research with grants from governmental agencies such as the National Institutes of Health and the National Science Foundation. Private foundations also provide grants to individuals and organizations. Some, such as the Kauffman Foundation or the Sapling Foundation, specifically support socially relevant activities.

COMMENTARY: Budgetary requests for grants usually include a list of expenditures (e.g., salaries, equipment, and travel) and associated amounts. The grantor also will request periodic reports summarizing actual expenditures on these line items and the status of the funded research. Account analysis for estimating and reporting costs is appropriate in these settings. Each project is unique, and applicants do not have historical cost data they could use to estimate costs.

EVALUATION OF THE ACCOUNT CLASSIFICATION METHOD

Because account classification requires us to examine each cost account in detail, it can provide very accurate estimates. Often, this analysis requires us to plot each cost account and examine the graph to determine its behavior. While some cost items will exactly correspond to the classical definitions of a fixed or variable cost, other cost items will require considerable judgment.

The major disadvantage of the account classification method is the difficulty associated with implementing it. Consider large firms such as General Motors or Microsoft. They offer a wide range of products, use a huge number of resources in their operations, and have expansive account lists. Even with advances in computer and information technologies, the account classification task would be daunting for such companies. Moreover, there is an element of subjectivity involved in classifying costs into variable and fixed categories. Classifications frequently require considerable knowledge and experience. Incorrectly classifying a fixed cost as variable (or vice versa) could lead to substantial errors in cost estimates.

Because the account classification method is both time-consuming and subjective in nature, many firms use techniques such as the high-low method and regression analysis. Such techniques are quantitative, objective, and less time consuming to implement.

High-Low Method

LEARNING OBJECTIVE 3

Compute fixed and variable costs using the high-low method.

The **high-low method** uses two observations of *aggregate* cost data to estimate *total* fixed costs and the unit variable cost. By doing so, the high-low method avoids the need to classify individual cost items as fixed or variable, making it less demanding than the account classification method.

To understand the high-low method, let us refer back to the scatter plots in Exhibit 4.4. As we observed earlier, panel A of this exhibit reveals no clear pattern

in the data as observations are all over the place. Panels B and C, though, reflect clear patterns indicating that there is an underlying "true" cost structure that relates the total cost to the activity volume. In the presence of such a definite relationship, the high-low method does a good job of identifying the fixed and variable portions of the total cost.

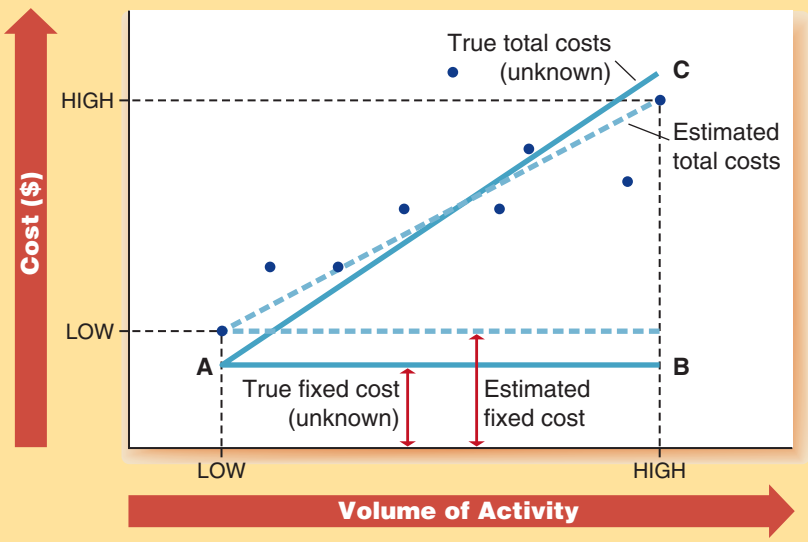
Exhibit 4.7 provides a graphical illustration of the high-low method. Let us assume that some "true" association exists between the total cost and the activity volume (as is the case, for example, in panel C of Exhibit 4.4). We represent this unknown true cost relation using a solid line. This line shows that fixed costs stay the same (the solid line AB) for all activity levels in the normal range of operations. The variable cost per unit (the slope of solid line AC) also remains the same. Then, for any volume of activity, total costs are:

$$\textit{Total costs} = \textit{Fixed costs} + (\textit{Unit variable cost} \times \textit{Volume of activity}).$$

Unfortunately, we do not *know* the *true* cost line; if we did, there would be no need to estimate anything! We only know actual costs and actual activities, and we must rely on these observations to *estimate* the true cost line.

In Exhibit 4.7, each observation (marked with "•") represents actual costs and actual activities for some period, such as a month. Actual activity levels vary across these periods because of demand fluctuations, causing total costs to

Exhibit 4.7 *Estimating Fixed and Variable Costs Using the High-Low Method*



CHAPTER CONNECTIONS

The high-low method classifies costs as either fixed or variable. This classification is useful for short-term decisions. As a decision's horizon expands, some fixed costs become controllable. In Chapter 9, we discuss methods that firms use to estimate the change in "fixed" costs over an extended horizon.

change as well. Actual costs differ from expected costs because of changes in prices and efficiencies. The dotted line that we will construct using the information from actual costs and activities represents our estimates of fixed and variable costs.

MECHANICS OF THE HIGH-LOW METHOD

The high-low method uses two observations to estimate total fixed costs and the variable cost per unit, or *unit variable cost*. By convention, managers use the two observations pertaining to the *highest and lowest activity levels*. These values are most likely to define the normal range of operations. (As is the case in Exhibit 4.7, the observations with the highest and lowest activity levels may not be the observations with the highest and lowest costs.) We then apply the cost equation to these two points:

$$\text{Total costs}_{\text{HIGH ACTIVITY LEVEL}} = \text{Fixed costs} + (\text{Unit variable cost} \times \text{Activity level}_{\text{HIGH}})$$
$$\text{Total costs}_{\text{LOW ACTIVITY LEVEL}} = \text{Fixed costs} + (\text{Unit variable cost} \times \text{Activity level}_{\text{LOW}})$$

From these equations, we can calculate the unit variable cost as:

$$\text{Unit variable cost} = \frac{\text{Total costs}_{\text{HIGH ACTIVITY LEVEL}} - \text{Total costs}_{\text{LOW ACTIVITY LEVEL}}}{\text{Activity level}_{\text{HIGH}} - \text{Activity level}_{\text{LOW}}}$$

We can then use this estimate of the unit variable cost with *either* the HIGH or the LOW total cost equation to estimate fixed costs. The observation we use does not matter.

$$\text{Fixed costs} = \text{Total costs}_{\text{HIGH}} - (\text{Unit variable cost} \times \text{Activity level}_{\text{HIGH}}).$$
$$\text{Fixed costs} = \text{Total costs}_{\text{LOW}} - (\text{Unit variable cost} \times \text{Activity level}_{\text{LOW}}).$$

As shown in Exhibit 4.7, the dotted line for estimated total costs will always pass through the observation points representing the total costs for the high and low activity levels used in the calculations. Why? The answer is simply that the line connects these two points. However, the line may or may not pass through the "o"s representing the other observations. The line is an *estimated* cost line, not the *true* cost line.

To estimate Hercules' variable costs and fixed costs using the high-low method, you could use GAAP income statement data; all you need are multiple observations about total costs and total activity levels. This is one of the advantages of the high-low method. To help you implement this method, Tom and Lynda provide you with their GAAP income statements for the previous six months, shown in Exhibit 4.8.

The high activity level is 1,250 members in August. The corresponding total cost ($63,000 in product costs + $15,000 in period costs) is $78,000. The low activity level is 1,000 members in January, and the corresponding total cost ($55,000 in product costs + $15,000 in period costs) is $70,000. Using these two data points, we estimate the following monthly variable cost per member and fixed costs under the high-low method:

$$\text{Monthly variable cost per member} = \frac{\$78{,}000 - \$70{,}000}{1{,}250 - 1{,}000} = \$32.$$

$$\text{Monthly fixed costs} = \$78{,}000 - (\$32.00 \times 1{,}250 \text{ members}) = \$38{,}000.$$

Exhibit 4.8 *Hercules Health Club: Income Statements for the Most Recent Six Months*

	Jan	Dec	Nov	Oct	Sep	Aug
Volume of Activity						
Number of members	1,000	1,075	1,100	1,150	1,200	1,250
Revenues	$80,000	$86,000	$88,000	$92,000	$96,000	$100,000
Costs of providing programs and services	55,000	58,000	58,000	59,000	61,000	63,000
Gross margin	$25,000	$28,000	$30,000	$33,000	$35,000	$37,000
Management salaries, marketing, and administration	15,000	15,000	15,000	15,000	15,000	15,000
Profit before taxes	$10,000	$13,000	$15,000	$18,000	$20,000	$22,000

Notice that we could have calculated monthly fixed costs using the low activity point, in which case our calculation would be:

$$\text{Monthly fixed costs} = \$70{,}000 - (\$32.00 \times 1{,}000 \text{ members}) = \$38{,}000.$$

Be mindful that the fixed cost number above represents the *total* fixed costs at the current level of operations. For the decision regarding yoga, we are interested in the change in fixed costs. We focus on the change because controllability, which identifies the costs and benefits to measure, refers to the change relative to the status quo.

Recall that, for Hercules, the change in annual fixed costs for the yoga decision is $12,000. Tom and Lynda expect the yoga program to lead to a net increase of 30 members. Using the high-low method, you estimate the total change in annual variable costs as ($32 variable cost per member per month × 30 members × 12 months) = $11,520. Therefore, you estimate total costs for the year to be $12,000 + $11,520 = $23,520.

Using the high-low method, you can now project the increased annual profit if Hercules offers yoga: ($28,800 in revenues − $23,520 in costs) = $5,280. Notice that our profit estimate of $5,280 differs from our estimate under the account classification method ($6,000); we are using a different method and different data to estimate the unit variable cost.

Check It! Exercise #2

Use the data from November and September to estimate the variable cost per member and monthly fixed costs. Verify that the estimated variable cost per member is $30 and the estimated monthly fixed costs are $40,000.

Difference in total costs _____
Difference in activity volume _____
Variable cost per member _____
Fixed costs per month _____

Solution at end of chapter.

Classifying costs as being fixed or variable can help improve decisions. (Mark Richards/ZUMA Press/©Corbis)

Connecting to Practice

Predicting Profits at Amazon.com

For the third quarter of 2002, Amazon.com reported the following numbers:

Revenues = $851.29 million
Cost of goods sold = $635.12 million, and
Profit = $216.17 million.

For the fourth quarter of 2002, Amazon.com reported:

Revenues = $1,428.68 million
Cost of goods sold = $1,093.49 million, and
Profit = $335.19 million, respectively.

Using these two points, we can estimate cost of goods sold as a function of revenues. The resulting relation is:

$$\text{Cost of goods sold} = -\$40.67 \text{ million} + (0.7938 \times \text{Revenues}).$$

Applying this equation to actual revenues of $1,083.59 million in the first quarter of 2003 gives a cost of goods sold estimate of $819.54 million and a profit estimate of $264.05 million. These estimates are close to the numbers actually reported, $813.01 million and $270.58 million, respectively.

Commentary: Using the high-low method and sales forecasts, we can predict profits at Amazon.com with reasonable accuracy. Notice, however, that our fixed cost estimate is negative. This illustrates that the estimated cost equation is only valid for the normal range of operations, which does not include zero sales!

EVALUATING THE HIGH-LOW METHOD

The high-low method is straightforward to use. It requires only aggregate department- or company-level cost data, readily available from a company's financial and cost records. Unlike the account classification method, it does not require analysis of the data at the individual account level. We can apply the high-low method even if we know only total revenues, total costs, and activity volume.

The high-low method poses two major concerns, however. First, it yields only rough estimates of fixed costs and the unit variable cost. It assumes that total cost varies *proportionately* with the volume of activity within the normal range of operations, and that this relation *does not change from period to period.* As we discussed in Chapter 2, some costs increase in proportion to the number of batches produced (batch-level costs), or only when there is an increase in the number of products produced (product-level costs). Because the high-low method does not separate such cost items, it misidentifies batch- and product-level costs as either variable or fixed costs, reducing the accuracy of the resulting estimates. It is possible to refine the high-low method to include batch-level and product-level costs. However, such refinements are cumbersome and diminish the high-low method's simplicity and ease of use.

Second, unusual cost deviations in the HIGH and LOW observations affect the high-low estimates and could increase estimation error significantly. Recall that the high-low method uses only two data points—even if more data points are available. Our estimates could be subject to significant error if these two HIGH and LOW observations are not representative. You could reduce the error by plotting the data, using

Excel or another spreadsheet program, and inspecting the plot for unusual observations. You also could guard against unusual cost deviations by generating multiple estimates of the unit variable cost using different sets of points to represent the HIGH and LOW activity levels. You could then average the estimate after discarding extreme values.

Would a more sophisticated method such as regression analysis overcome the deficiencies of the high-low method? Let us consider this question next.

Regression Analysis

LEARNING OBJECTIVE 4

Perform regression analysis to estimate fixed and variable costs.

Regression analysis is a statistical method for estimating fixed and variable costs. In contrast to the high-low method, which only uses two past observations to estimate fixed and variable costs, the regression method uses *all* available observations to come up with a line that best "fits" the data. (To be precise, the regression line minimizes the sum of the squared deviations between the points and the line.) Although each observation may deviate somewhat from the line, regression analysis efficiently uses the information in each observation. Consequently, this method results in the least error between the estimated and the true total cost line.

Explaining the mechanics of regression analysis is beyond the scope of this book. Instead, we show you how to use Excel to fit a regression line to a given set of data. We also discuss how to interpret the results provided by Excel.

Exhibit 4.9 provides the past 12 months of membership and cost data for Hercules, starting with the most recent month. The following steps will fit a regression line to this data.

1. Open Excel. Enter the months in column A, the volume of activity (# of members) in column B, and the total costs in column C. (Use a heading, or title, for each column).
2. From the *Tools* menu, choose the *Data Analysis* option.
3. From the *Options* box, choose *Regression.*

Exhibit 4.9 *Hercules Health Club: Membership and Cost Data for the Past 12 Months*

Month	Volume of Activity (# of members)	Total Costs
Jan	1,000	$70,000
Dec	1,075	73,000
Nov	1,100	73,000
Oct	1,150	74,000
Sep	1,200	76,000
Aug	1,250	78,000
July	1,240	76,250
June	1,260	77,500
May	1,235	75,500
April	1,275	76,800
March	1,300	80,500
Feb	1,280	79,000

4. You will see a dialog box, as shown in Exhibit 4.10.
   a. Enter the *y*-axis cell range (total costs) and the *x*-axis cell range (# of members) as shown.
   b. Check the *Labels* option to include the title cells in the range.
   c. Choose the *Line Fit Plots* option if you would like to see a graph of the fitted line.
   d. Click *OK*, and you should see the results (as in Exhibit 4.11) in a separate worksheet.

Exhibit 4.10 *Regression Dialog Box in Excel*

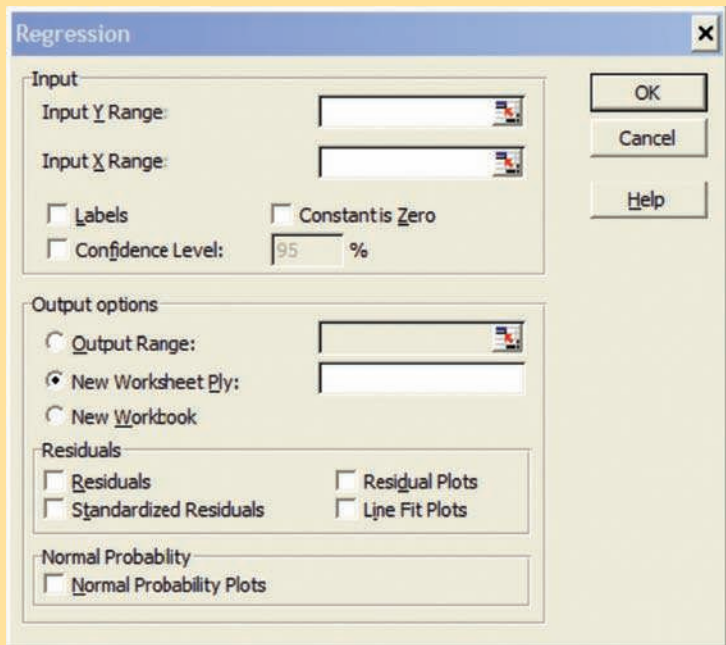


Exhibit 4.11 *Excel Screenshot of Regression Output*

	A	B	C	D	E
1					
2		*Regression Statistics*			
3		Multiple R	0.951128423		
4		R Square	0.904645277		
5		Adjusted R Square	0.895109805		
6		Standard Error	946.5090968		
7		Observations	12		
8					
9	ANOVA				
10		*df*	*SS*	*MS*	*F*
11	Regression	1	84993496.96	84993497	94.87158
12	Resicual	10	8958794.704	895879.5	
13	Total	11	93952291.67		
14					
15		*Coefficients*	*Standard Error*	*t Stat*	*P-value*
16	Intercept	40715.87661	3611.912408	11.27266	0.01
17	Activity level (# of members)	29.30452354	3.008614941	9.740204	0.01

Check It! Exercise #3

Suppose Tom and Lynda wish to use the regression equation you developed to predict costs for February. Verify that their expected total cost for February is $70,015.88 at a volume of 1,000 members.

Unit variable cost (slope of regression equation)	_____
× Number of members	× 1,000
= Total variable costs	_____
+ Fixed costs (Intercept of regression equation)	_____
= Total costs	_____

Solution at end of chapter.

To interpret the results, refer to Exhibit 4.11. The first cell under the column headed *Coefficients* estimates the intercept of the line. This amount, $40,715.88, represents our estimate of Hercules' monthly fixed costs. The second cell under the column headed *Coefficients* estimates the slope of the regression line. This amount, $29.30, is our estimate of Hercules' variable cost per member per month.

Because regression is a well-defined statistical method, it provides a number of other statistics that help us evaluate the fitted line. We draw attention to the R-square for the regression and the *p*-value for each coefficient. The value of the R-square indicates the goodness-of-fit. The R-square will always lie between zero and one. The closer this number is to one, the better the fit. The R-Square for this regression is 0.9046, which indicates a very good fit. The *p*-value indicates the confidence that the coefficient estimates reliably differ from zero. Usually, we look for *p*-values lower than 0.05, with lower values representing tougher thresholds to meet. In other words, a *p*-value of less than 0.01 indicates a sufficiently high level of confidence in the estimates.

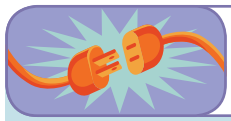
For Hercules, recall that controllable fixed costs are $12,000 and that Tom and Lynda expect the yoga program to lead to a net increase of 30 members. Using the regression analysis value of $29.30 for the unit variable cost, you estimate the annual controllable costs from offering yoga as

$$\$12{,}000 + (29.30 \times 30 \text{ members} \times 12 \text{ months}) = \$22{,}548.$$

In turn, calculating ($28,800 in revenues − $22,548 in costs), you project an increase in annual profit of $6,252 if Hercules offers yoga. Again, because we used a different method and different data, our estimate under regression analysis differs from our earlier estimates.

EVALUATION OF THE REGRESSION METHOD

A major drawback of using regression analysis is that the technique makes a number of assumptions about the data, and accounting data sometimes do not satisfy these assumptions. In these cases, users are required to correct the data or adjust the analysis. For example, one might think that expenditures on equipment maintenance are consistent throughout the year, with monthly and weekly checkups. However, firms usually schedule maintenance after periods of heavy usage. Thus, machine hours in one month might relate to maintenance expenditures in the following month. Obtaining reliable estimates also requires many observations. Overall, while we introduce you to regression analysis, we also urge caution when using it.



Connecting to Practice

Statistical Analysis and Credit Scoring

Credit ratings influence the interest rates that consumers pay on loans. Rating agencies such as Experian provide credit scores for individuals in the United States. A poor rating could raise the interest rate on a mortgage considerably. Organizations such as Standard and Poor's provide a similar service for businesses.

Commentary: Rating agencies develop and use regression models to determine the weights that aggregate these factors into a composite credit rating. In these regression models, credit rating is the dependent variable (like total costs in our cost model), and factors such as previous payment behavior, amount of outstanding debt, type of credit used (e.g., credit card versus home loan), and proportion of total available credit being used are independent variables (like the activity volume in our cost model).

CHOOSING AN APPROPRIATE METHOD

Each of the three techniques we considered for estimating fixed and variable costs has pluses and minuses. Fortunately, as shown in the accompanying summary table, all three methods show that Hercules would increase annual profit by at least $5,280 if it offers yoga. Your recommendation is clear.

Will the methods always agree? What happens if the methods lead to different choices? How should you pick the best method? Fortunately, in most instances, the three methods lead to similar results. The choice of a particular method depends on how best we can implement each of these techniques in a given setting. For example, given its ease of implementation, the high-low method may be

APPLYING THE DECISION FRAMEWORK

What Is the Problem?

Hercules is losing membership to the competition, Apex Health & Fitness. This erosion in membership adversely affects Tom and Lynda's goal of maximizing the profit from their health club.

What Are the Options?

(1) Offer yoga; (2) do not offer yoga.

What Are the Costs and Benefits?

It will cost Hercules $10,000 to hire a yoga instructor for the year, and Tom and Lynda plan to spend $2,000 advertising the program. Finally, Hercules expects to attract 30 new members by offering yoga. In sum, we calculated the change in profit from offering yoga as:

Account classification	$6,000
High-low method	$5,280
Regression analysis	$6,252

Make the Decision!

Based on your calculations, you expect the yoga class to increase Hercules' annual profit by at least $5,280. You recommend to Tom and Lynda that they offer the yoga class.

particularly appropriate and sufficiently accurate when the variability of costs is relatively stable over time.

We might prefer account analysis in other settings. Suppose the TB Alliance, a nonprofit organization dedicated to the development and distribution of tuberculosis drugs, is planning to open a clinic in Africa. In this case, there may not be any past data to analyze, and the high-low method and regression analysis might only be of limited use. You might find that account analysis, which helps to project the change in individual cost elements, provides the most reliable estimates. The high-low method and regression analysis might be of less use here because the underlying cost structure of the new operations might differ from the current state of affairs.

Regression analysis is particularly useful in extracting information about complex patterns in cost data. Investing in such analysis is most worthwhile for large problems that involve significant cash flows and where small errors can be extremely costly.

Keep in mind that we have focused our attention only on those costs and revenues that are quantifiable. Often, it is difficult to quantify certain costs and benefits in dollar terms. Nonprofit organizations such as the Gates Foundation might spend several million dollars on advertising that promotes the health benefits from vaccinations. Commercial enterprises such as Nike advertise to promote their image. In both cases, expected benefits are hard to express in dollar terms. The benefits of image advertising are not as measurable as those from a promotional campaign where customers must return a coupon to receive a product discount.

Similarly, organizations consider the effect on employee morale when making layoff decisions. Do the remaining employees work harder to prove they deserve to hold on to their jobs. Or does their morale drop, leading to lower productivity, increased absences, and greater job turnover? How should we include such *hard to quantify* costs or benefits? Usually, we have to rely on subjective estimates or approximations. Good managers consider tangible costs first and fold in the intangibles second, even if only on a subjective or judgmental basis. They then combine both the objective and subjective factors to pick the option that meshes best with their goals.

Remember that, for all three techniques, we assumed that revenues and variable costs are proportional to activity volume. This assumption is only valid in the **relevant range**, or the normal range of operations. In the relevant range, we expect a stable relation between activity and cost. Outside the relevant range, costs and revenues may not bear the same direct relation with activity volume, or fixed costs may change.

Consider a firm that normally produces between 1,500 and 3,000 units per month. Suppose that we estimate fixed costs at $25,000 per month and the unit variable cost at $12. Then, the estimated total monthly cost of producing and selling 2,000 units is:

$$\text{Total monthly cost of producing 2,000 units} = \$25{,}000 + (\$12 \times 2{,}000) = \$49{,}000.$$

Can we use this equation to predict costs for making 20,000 units a month? Using the equation, our estimate of total costs is $265,000 (= $25,000 + $12/unit × 20,000 units). However, we cannot trust this estimate. Fixed costs are likely to be much higher if the firm increases its volume of operations that significantly. Existing capacity may

Check It! Exercise #4

Verify that the total monthly cost of producing 1,600 units is $44,200 and that the total monthly cost of producing 2,750 units is $58,000.

Solution at end of chapter.

be sufficient to support only the normal range of 1,500 to 3,000 units. For 20,000 units a month, more capacity may be required, meaning that fixed costs will increase well beyond the estimate of $25,000 per month. Similarly, due to economies of scale and learning by doing, the unit variable cost may decrease if the company substantially increases output volume. In Appendix A, we discuss a more advanced technique for cost estimation in situations where learning takes place.

What does this mean for Hercules? Based on the information in Exhibit 4.9, Hercules' relevant range spans from 1,000 to 1,300 members. Tom and Lynda can be more confident when using the cost equations we estimated for a volume of 1,150 members than for a volume of 2,000 members. Outside the relevant range, both fixed and variable costs may differ significantly from our estimates.

Now that you understand how to estimate the variable and fixed portions of a company's cost structure, and how to present this information clearly and conveniently using the contribution margin format for a single product, the next step is to extend these concepts to more general settings.

Segmented Contribution Margin Statements

LEARNING OBJECTIVE 5

Construct segmented contribution margin statements.

Most firms offer many products and operate in multiple geographical regions. The "segmented" contribution margin statement is one way these firms modify the contribution margin statement to reflect the greater complexity of their operations.

PRODUCT-LEVEL CONTRIBUTION MARGIN

Exhibit 4.12 presents a contribution margin statement, organized by product, for Office Gallery, the merchandising firm we studied in Chapter 3. Each column in the statement begins with sales volume and revenues. For simplicity, we do not show the flow of merchandise inventory for each product. Total revenues and profit before taxes correspond to the amounts reported earlier in Exhibit 3.4. As with Hercules, for each product, the *contribution margin* equals revenues less variable costs.

For each product, we compute the **segment (product) margin** by subtracting the fixed costs traceable to that product from its contribution margin. These

Exhibit 4.12 *Office Gallery: Product-Level Contribution Margin Statement*

	Chairs	Desks	Bookshelves	Total
Sales volume (in units)	45,250	32,200	52,000	
Revenues	$24,887,500	$23,345,000	$15,600,000	$63,832,500
Cost of merchandise sold	17,557,000	16,422,000	11,122,350	45,101,350
Variable transportation in	543,000	901,600	1,396,300	2,840,900
Variable selling & administrative costs	407,250	418,600	421,020	1,246,870
Contribution margin	$6,380,250	$5,602,800	$2,660,330	$14,643,380
Traceable Fixed Costs	1,950,000	1,745,000	2,857,000	6,552,000
Segment (product) margin	$4,430,250	$3,857,800	($196,670)	$8,091,380
Common Fixed Costs				4,469,690
Profit before taxes				$3,621,690

Check It! Exercise #5

Verify that Office Gallery's contribution margin and profit would *decrease* by $26,000 if a customer offered to buy 1,000 desks for $525 per desk.

Solution at end of chapter.

fixed costs are not relevant for decisions involving increasing or decreasing production volumes. However, these fixed product-level costs are controllable with respect to the decision of adding or dropping a segment. For example, Office Gallery could lower fixed costs by $2,857,000 if it decides to stop producing bookshelves.

We compute profit before taxes by summing all segment margins and then subtracting common fixed costs. These common fixed costs, or facility-level costs, do not relate to any product in particular but to the entire business. They are not controllable at the product level.

How does such detail help? Suppose that Office Gallery has a one-time offer from a customer to purchase 1,000 chairs for $500 per chair. Even though the offer is below the usual selling price of $550 per chair ($550 = $24,887,500 in chair revenues/45,250 chairs sold), Office Gallery is willing to consider this offer for strategic reasons, provided the deal does not "lose money."

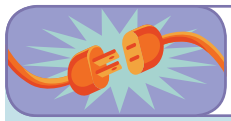
Accepting the offer increases Office Gallery's revenues by 1,000 chairs × $500 per chair = $500,000. From Exhibit 4.12, we can calculate that the variable cost per chair is $18,507,250 total variable costs/45,250 chairs = $409. Accepting the offer increases total variable costs by 1,000 chairs × $409 per chair = $409,000. Thus, accepting the offer increases Office Gallery's contribution margin by $500,000 − $409,000 = $91,000. This also is the net change in profit because neither traceable nor common fixed costs would change due to this decision.

REGION- AND CUSTOMER-LEVEL CONTRIBUTION MARGIN STATEMENTS

When constructing segmented statements, we use the term *segment* in a broad sense, with the specific meaning dependent on the decision context. Exhibit 4.12 defines each product as a segment. Thus, we could have used the term *product margin* instead of segment margin. In a similar fashion, we could define a specific store, region, or customer as a segment. The corresponding statements would yield store-level, regional, and customer-level contribution margins and profit.

Suppose that Office Gallery sells its products throughout the United States. It divides the country into its three primary geographical regions for organizing its sales and distribution activities. Assume the company is considering whether to continue its presence in a specific geographical region. For this decision, Office Gallery would prepare a contribution margin statement that divides the firm by geographic region, informing management of the profit by region. In this case, each geographic region is a segment.

We could combine two or more segments into one statement. For example, regional statements might also break out regional sales by product line. Thus, we could identify the contribution from the sale of chairs in the Mid-Atlantic region. In theory, there is no limit to how many segments we report. In practice, the difficulty of determining the traceability of costs to each segment limits the detail reported.



Connecting to Practice

Segment Disclosure

Johnson & Johnson reports select financial data such as sales, operating profit, and assets by its three major segments: (1) Consumer; (2) Pharmaceutical; and, (3) Medical Devices and Diagnostics. Johnson & Johnson also reports data by four geographic areas: (1) United States; (2) Europe; (3) the Western Hemisphere excluding the United States; and (4) Asia-Pacific/Africa.

Commentary: We have discussed organizing information *within* the firm to facilitate effective decisions. However, firms that have significant operations in foreign countries and/or in distinct product markets *must report* investment, sales, and profit information by geographic region and/or operating segment. Regulators believe these data help an investor better value the firm's future prospects.

Summary

In this chapter, we discussed how to use available financial data to estimate the profit of short-term options. Because many costs are fixed and noncontrollable in the short term, we need to separate variable costs from fixed costs. We described three techniques to accomplish this objective: the account classification method, the high-low method, and regression analysis, as well as the advantages of each method. We learned how we could use these techniques, and the resulting contribution margin statement, to make effective decisions. Finally, we learned how to construct segmented contribution margin statements for firms that have multiple products and customers or that operate in multiple geographical regions.

In Chapter 5, we build on the material in the current chapter by expressing a firm's profit as a function of price, unit variable cost, sales volume, and fixed costs. We then illustrate how to use the resulting equation for profit planning, breakeven analysis, assessment of operating risk, and short-term decision making.

Rapid Review

LEARNING OBJECTIVE 1

Prepare a contribution margin statement.

- The contribution margin statement groups costs by their variability, reporting fixed costs and variable costs as separate line items. The contribution margin is the amount that remains after subtracting variable costs from revenues, contributing toward recovering fixed costs and earning a profit.
- The contribution margin statement is particularly helpful for short-term decisions because variable costs are controllable for short-term decisions, whereas fixed costs are not.
- Firms use three techniques to construct contribution margin statements: (1) account-classification, (2) high-low method, and (3) regression analysis.

LEARNING OBJECTIVE 2

Use the account classification method to identify fixed and variable costs.

- The account classification method involves systematically classifying a company's list of cost accounts into fixed and variable categories.
- The account classification method is detailed and can provide very accurate estimates if done correctly. However, it is time consuming and subjective.

LEARNING OBJECTIVE 3

Compute fixed and variable costs using the high-low method.

- The high-low method uses historical cost data to estimate total fixed and unit variable costs. The method uses two observations—the high activity level and the low activity level—to estimate the cost equation.
- The high-low method is straightforward to use. However, it assumes that the cost structure of a company does not vary over time and uses only two data points.

LEARNING OBJECTIVE 4

Perform regression analysis to estimate fixed and variable costs.

- Regression analysis is a statistical method for estimating fixed and variable costs. The regression method uses all available data to come up with a line that best fits the data.
- The major advantage of regression analysis is that it uses all available data to estimate the cost equation. It also provides a number of statistics to help evaluate the fitted equation.
- A major drawback of using regression analysis is that the technique makes a number of assumptions about the structure of the data. Accounting data may not satisfy these assumptions, requiring users to make adjustments.

LEARNING OBJECTIVE 5

Construct segmented contribution margin statements.

- Firms operating with many product lines and/or in many regions might construct a segmented contribution margin statement.
- A segmented contribution margin statement reports the following: (1) contribution margin, which equals revenues less all variable costs; (2) segment margin, which equals the contribution margin less traceable fixed costs, and (3) profit before taxes, which equals the segment margin less common fixed costs. This detail allows the firm to make decisions at the level of an individual product, segment, or the firm as a whole.

Chapter 4 Appendix

LEARNING CURVES AND COST ESTIMATION

On many repetitive projects, such as the manufacture of airplanes, ships, computers, and spacecraft, the amount of labor time required decreases with every succeeding unit. Why? As people gain experience, they can produce each unit more efficiently than the preceding one. For example, on the first unit, a worker may frequently consult a blueprint to install virtually every part. On the second unit, the worker may remember what part of the blueprint to look at in order to find out how to install a part. Eventually, the worker may simply remember where and how to install a particular part, without referring to the blueprint. Consequently, the required labor time decreases, which should also decrease labor cost.

Studies conclude that an exponential curve represents well the relation between labor time and production. Rather than going into all of the technical details, we illustrate what is termed a "doubling approach." This approach says that as the production volume doubles, the average time required decreases by a fixed percentage. For example, if it takes 500 hours to produce the first unit of production, and the product is subject to a 90% learning effect, then the average time to produce two units (a doubling of production) will be 90% of 500 hours, or 450 hours. Similarly, the average time to produce four units (another doubling of production) will be 90% of 450 hours, or 405 hours.

Notice that the calculation results in the *average* time to produce all units to date. Thus, to find the *total* time to produce the first two units, we multiply the average

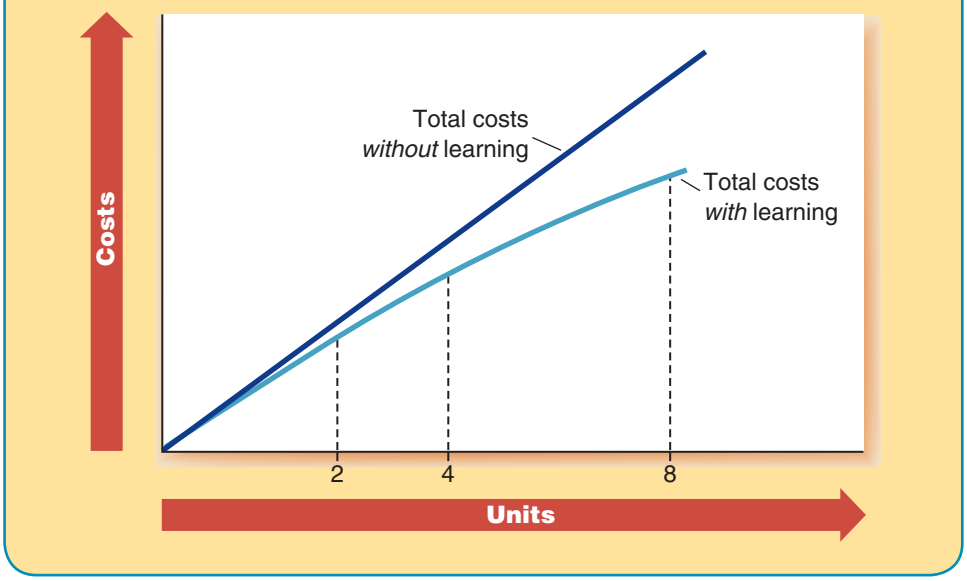
Exhibit 4.13 *Example of Cost Behavior with Learning (90% Learning Effect)*

Total Number of Units Produced	*Average* Time to Produce all Units to Date*	*Total* Time to Produce all Units to Date**
1	500.00	500.00
2	450.00	900.00
4	405.00	1,620.00
8	364.50	2,916.00
16	328.05	5,248.80

* The first unit takes 500 hours. Every time production doubles, we take the previous average time and multiply it by 0.90 to obtain the new average time. For example, the average time to produce 8 units = 405 × 0.90 = 364.05.

** Total number of units produced × Average time to produce all units to date.

Exhibit 4.14 *Learning by Workers Reduces Total Cost in a Predictable Way*



time for the two units by 2, to yield 450 hours × 2, or 900 hours. Similarly, the time to produce four units is 405 hours × 4, or 1,620 hours. Exhibit 4.13 represents costs with learning in a tabular format. Exhibit 4.14 provides the graphical intuition, showing that costs increase at a decreasing rate with learning.

If we wish to know the time to produce just the third and fourth units, we must calculate the total time to produce all four units and subtract the time to produce the first two units. In this way, we get the additional time to produce the last two units. In the example given, the last two units should require 1,620 hours − 900 hours, or 720 hours to complete.

Learning curves are an empirical phenomenon. There is little theoretical basis for figuring out why a certain learning curve exists. Organizations use prior experience to forecast learning effects and cost savings. The cost savings can be huge. For example, a handful of firms, including Intel, dominate the market for computer chips because the learning that new entrants require poses a significant entry barrier. Thus, when analyzing costs, we find it useful to ask if learning is expected and, if so, to determine its magnitude.

Answers to Check It! Exercises

Exercise #1: Hercules' rental cost does not change by offering yoga. Hercules will incur this cost regardless of Tom and Lynda's decision. The decrease in salaries paid would be a benefit. We would include the amount as a controllable fixed cost with a negative value.

Exercise #2: Difference in total costs = $76,000 − $73,000 = $3,000; Difference in activity volume = 1,200 − 1,100 = 100 members; Variable cost per member = $3,000/1,000 = $30; Fixed costs per month = $76,000 − ($30 × 1,200) = $40,000 OR, equivalently, $73,000 − ($30 × 1,100).

Exercise #3: Unit variable cost = $29.30; Total variable costs = $29.30 × 1,000 = $29,300; Fixed costs = $40,715.88; Total costs = $29,300 + $40,715.88 = $70,015.88.

Exercise #4: Total monthly cost of producing 1,600 units = \$25,000 + (\$12 × 1,600) = \$44,200; Total monthly cost of producing 2,750 units = \$25,000 + (\$12 × 2,750) = \$58,000

Exercise #5: Total variable costs are \$16,422,000 + \$901,600 + \$418,600 = \$17,742,200. Thus, each desk has a variable cost of (\$17,742,200/32,200) = \$551. In turn, Office Gallery would experience a negative contribution of \$26 per desk that it sells for \$525. At a volume of 1,000 desks, Office Gallery would lose \$26,000. Notice that fixed costs are not controllable for this decision.

SELF-STUDY PROBLEMS

Total costs increase with the number of bats produced. (©John Sommers II/ Reuters/©Corbis)

Gwynn, Inc. specializes in making baseball bats. Exhibit 4.15 presents production and cost data for the past 12 months of operations.

Exhibit 4.15 *Gwynn, Inc.: Monthly Production & Cost Information*

Month	Bats Produced	Total Costs
January	18,500	\$ 875,000
February	35,000	1,340,000
March	45,000	1,472,000
April	27,000	1,050,000
May	30,000	1,215,000
June	34,000	1,300,000
July	42,000	1,541,000
August	38,000	1,445,000
September	33,000	1,275,000
October	17,000	840,000
November	18,000	870,000
December	15,000	812,000

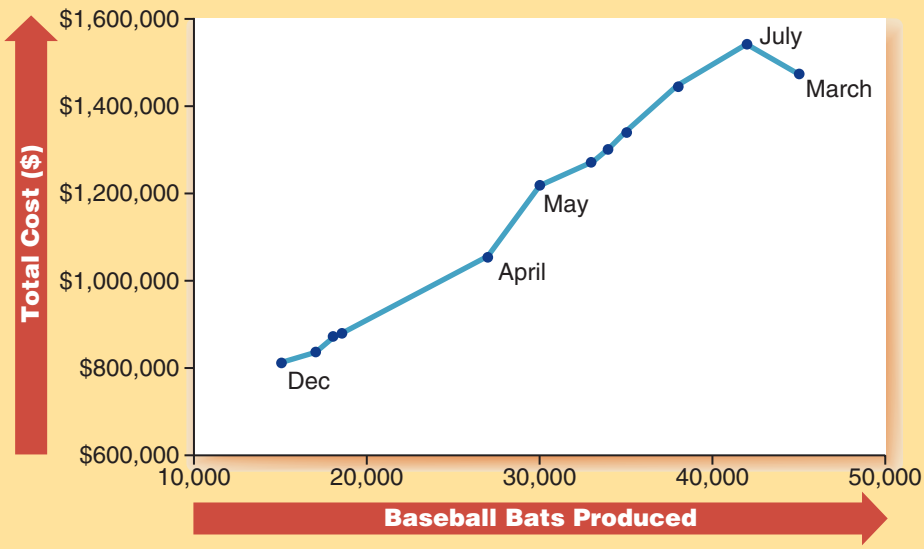
a. *Graph the relation between Gwynn's total costs (y-axis) and the number of baseball bats produced (x-axis). Do any particular data points strike you as being "odd?"*

The graph in Exhibit 4.16 depicts the relation between Gwynn's total costs and bats produced. Please note that this scatter plot sorts the data in Exhibit 4.15 by the number of bats produced to help us evaluate the relation between the driver (bats produced) and costs.

Two features of the data are particularly notable. First, the total cost of \$1,472,000 for producing 45,000 bats in March is *lower* than the total cost of \$1,541,000 for producing 42,000 bats in July. Cost has decreased even though production volume has increased! This anomaly suggests caution in using the data from March. It is possible that the firm recorded some costs incorrectly or, worse, failed to record some costs.

Second, the plot shows a somewhat marked increase in total costs when production increases from 27,000 bats in April to 30,000 bats in May (the line connecting the April and May data is steeper than any other line). This jump suggests the presence of some step costs—perhaps Gwynn needed to purchase some additional equipment or hire more salaried personnel. Detailed account analysis can help identify these specific costs.

Exhibit 4.16 *Gwynn, Inc.: Scatter Plot of Total Costs and Bats Produced*



b. *Estimate Gwynn's monthly total fixed costs and variable cost per bat produced using the high-low method.*

The highest level of activity, measured in the number of bats produced, is in March (45,000 bats, total cost = $1,472,000). Recall that we identified March as being somewhat of an unusual month in part (a) and advocated caution using the data from this month. In this part, we will continue to view March as having the highest level of activity, but will address some concerns from doing so later in parts (c) and (d). The lowest level of activity is in December (15,000 bats, total cost = $812,000). Thus:

$$\text{Activity level}_{\text{HIGH}} = 45{,}000 \text{ bats; Activity level}_{\text{LOW}} = 15{,}000 \text{ bats}$$

$$\text{Total cost}_{\text{HIGH}} = \$1{,}472{,}000; \text{ Total cost}_{\text{LOW}} = \$812{,}000$$

The high-low estimate for the unit variable cost is:

$$\text{Unit variable cost} = \frac{\text{Total cost}_{\text{HIGH}} - \text{Total cost}_{\text{LOW}}}{\text{Activity level}_{\text{HIGH}} - \text{Activity level}_{\text{LOW}}}$$

$$= \frac{\$1{,}472{,}000 - \$812{,}000}{45{,}000 - 15{,}000} = \$22.00$$

$$\text{Fixed costs} = \text{Total cost}_{\text{HIGH}} - (\textit{Unit variable cost} \times \text{Activity level}_{\text{HIGH}})$$

$$= 1{,}472{,}000 - (22.00 \times 45{,}000) = \$482{,}000$$

Equivalently, we can also calculate fixed costs using $\text{Total cost}_{\text{LOW}}$ and $\text{Activity level}_{\text{LOW}}$ as

$$\text{Fixed costs} = \text{Total cost}_{\text{LOW}} - (\textit{Unit variable cost} \times \text{Activity level}_{\text{LOW}})$$

$$= \$812{,}000 - (22.00 \times 15{,}000) = \$482{,}000$$

The resulting monthly cost equation is:

$$\textit{Total monthly costs} = \$482{,}000 + (\$22.00 \times \textit{Number of bats})$$

c. *Estimate Gwynn's monthly fixed costs and variable cost per bat produced using the data from December and July.*

For December, total costs were $812,000 and the corresponding number of bats produced was 15,000.
For July, total costs were $1,541,000 and the corresponding number of bats produced was 42,000.
With these two data points, we have:

$$\text{Unit variable cost} = \frac{\$1{,}541{,}000 - \$812{,}000}{42{,}000 - 15{,}000} = \$27.00$$

$$\text{Fixed costs} = \text{Total cost}_{\text{JULY}} - (\text{unit variable cost} \times \text{Activity level}_{\text{JULY}})$$
$$= 1{,}541{,}000 - 27.00 \times 42{,}000 = \$407{,}000$$

The resulting monthly total cost equation is:

Total monthly costs = $407,000 + ($27.00 × Number of bats)

d. *Graph the cost equations you estimated in parts (b) and (c) against the actual data. Based on your graphs, which of the two cost equations do you believe is likely more representative of Gwynn's true cost equation— the one you identified in part(b) or the one you identified in part(c)?*

Exhibit 4.17 shows the estimate we arrived at in part (b) given the actual data for March and December.

Exhibit 4.17 *Gwynn, Inc.: Estimated Relation between Total Costs and Bats Produced*

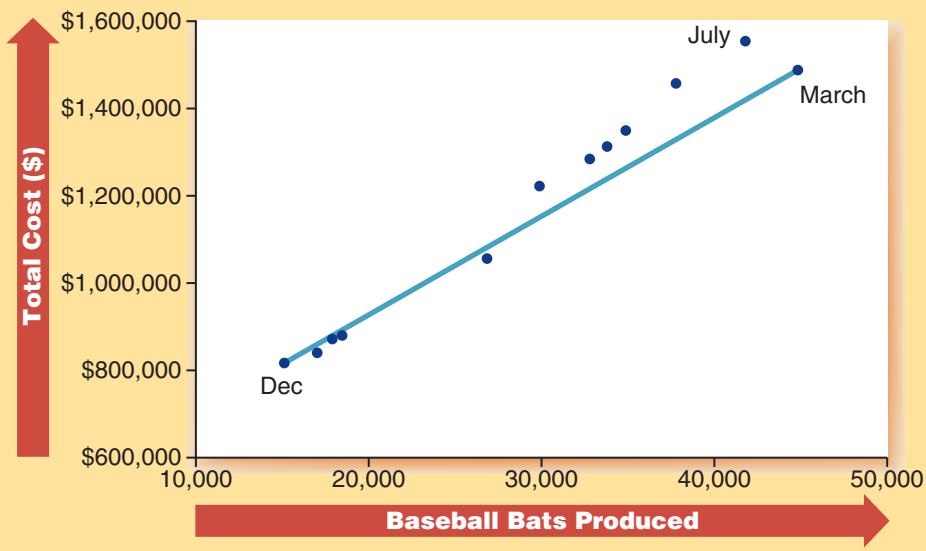
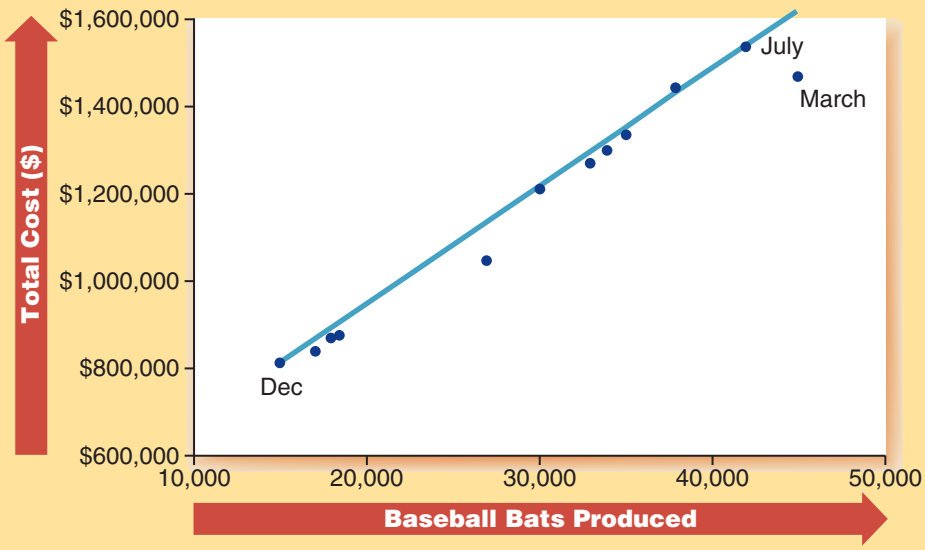


Exhibit 4.18 shows the estimate we arrived at in part (c) given the actual data for July and December.

With the exception of March, the estimate in part (c) appears to fit the data better than the estimate in part (b). That is, using the data from December and July leads to smaller differences between actual and predicted costs than using the data from December and March. (This preference occurs even though we used the month of December in both specifications.) In short, it is likely that the estimate in part (b) contains error because of the "odd" behavior of the data for March.

This scenario underscores the importance of graphing the data. Graphing the data and ensuring data reliability are crucial steps before using any technique to estimate costs. Graphing

Exhibit 4.18 *Gwynn, Inc.: Estimated Relation between Total Costs and Bats Produced*



the data is an excellent way to gain intuition regarding the relation between activity levels and costs. Graphs are also useful in identifying unusual and extreme observations that should not be used in estimation.

e. *Estimate Gwynn's monthly total fixed costs and variable cost per bat produced using regression analysis. Follow the steps outlined in the chapter and use all available data.*

Following the steps outlined in the chapter, we arrive at the following cost equation using regression analysis.

$$\textit{Total monthly costs} = \$411{,}422 + (\$25.81 \times \textit{Number of bats})$$

This estimate is "closer" to the estimate we arrived at in part (c), further increasing our confidence that the cost equation we arrived at in part (c) better represents Gwynn's costs than the cost equation we arrived at in part (b).

GLOSSARY

Account classification method A cost estimation technique that involves systematically classifying a company's list of cost accounts into fixed and variable categories.

Contribution margin Revenues less variable costs.

Contribution margin statement An income statement that groups costs by their variability, reporting variable costs and fixed costs as separate line items.

Cost structure The proportion of total costs that are fixed and variable.

High-low method A cost estimation technique that uses two observations pertaining to the highest and lowest activity levels to estimate fixed and variable costs.

Regression analysis A statistical method that uses all available observations to estimate fixed and variable costs.

Relevant range A firm's normal range of operations. Over this range, we expect a stable relation between activity and cost.

Segment (product) margin The contribution margin of a segment (e.g., product, customer, geographical region) less traceable fixed costs.

Review Questions

4.1 LO1. Why is the traditional income statement, used for financial reporting, often not helpful for decision making?

4.2 LO1. What is the contribution margin?

4.3 LO1. How does the format for the contribution margin statement differ from the format for the GAAP-based income statement?

4.4 LO1. Does the contribution margin change proportionally with activity volume?

4.5 LO1. How does the organization of data in a contribution margin statement help firms make better decisions?

4.6 LO2. What are the three techniques used to estimate costs?

4.7 LO2. What three steps are followed under the account classification method to estimate the change in variable costs?

4.8 LO2. List one advantage and one disadvantage of the account classification method.

4.9 LO3. Which two observations are used by the high-low method?

4.10 LO3. List one advantage and one disadvantage of the high-low method.

4.11 LO3. In contrast to the high-low method, how many observations does regression analysis use to estimate fixed and variable costs?

4.12 LO4. What are two statistics that help us evaluate the results from regression analysis?

4.13 LO4. What is the relevant range?

4.14 LO5. What is a segment margin? How does it differ from a contribution margin?

4.15 LO5. List three possible ways in which a company might wish to segment its contribution margin income statement.

Discussion Questions

4.16 LO1. Which of the following would trigger a larger decrease in unit contribution margin: a 5% decrease in the selling price or a 5% decrease in variable costs? Why?

4.17 LO1. Why might investors prefer an income statement in the gross margin format even though managers might prefer to organize the data in the contribution margin format?

4.18 LO1. Why is the contribution margin statement more useful for making short-term decisions than it is for long-term decisions?

4.19 LO1. How can plotting the data help improve cost estimation?

4.20 LO1. Suppose you are plotting monthly data (12 observations) from last year. Why might you wish to sort the data by activity volume before plotting it? That is, why might you not use months as the *x*-axis in your graph?

4.21 LO2. Why is account classification a preferred method for estimating costs when submitting a proposal for grant funding? For example, a not-for-profit organization might apply to the Gates Foundation for a program grant.

4.22 LO2. A manager might not be as confident in her ability to estimate costs for large, one-of-a-kind projects as for smaller decisions that are of a routine nature. Yet, we might prefer account classification for large projects and mechanical methods such as the high-low method for smaller, routine decisions. Explain this seeming inconsistency.

4.23 LO3. As discussed in the chapter, the accuracy of the cost estimates derived using the high-low method depends crucially on picking the "right" observations. How can you visually verify that the high and low data points are "representative?"

4.24 LO2, LO3. Can you identify two reasons why the high-low estimate of Hercules' variable cost per member differs from the account classification estimate?

4.25 LO3. "It is important to remove outliers in the high-low method because we only use two observations. Removing extreme observations that might not skew results is not as important when using regressions because an outlier is only one of many observations." True or False? Explain.

4.26 LO4. Going back to obtain historical data from many years is one way to increase the number of data points we use in a regression. What are the potential issues with this approach?

4.27 LO4 (Advanced). How could we include batch- and product-level activities in regression analysis? Is it appropriate to interpret the intercept as "facility-level costs?"

4.28 LO4 (Advanced). Gyms such as Hercules often offer both individual and family memberships. For example, a family membership would give access up to four individuals, but the family membership will cost less than four individual memberships. How does this feature affect the estimation methods described in this chapter? What additional assumptions, if any, do we need to implement these methods?

4.29 LO5. Does it make sense to construct a contribution margin statement by customer? Why or why not? What kinds of decisions might such a statement facilitate?

4.30 LO5. If a firm drops a product line, it will lose the revenue from that product. This loss is controllable

and direct with respect to the decision to keep or drop the product. Dropping a product might also affect the sales of the firm's other products. Give two examples—one where the spillover effect increases the revenue from other products and one where the spillover effect decreases the revenue from other products. Are these spillover effects controllable and direct to the decision to drop the product?

4.31 LO5. Browse the Web site of General Electric Corporation (http://www.ge.com) or another firm of your choice. Locate the *Investor relations* section and browse the latest annual report. Can you identify the data reported by segments? (*Hint*: These data are often reported in the "notes to the financial statements," with the results being discussed in the "management discussion and analysis.")

EXERCISES

4.32 Contribution margin statement (LO1). Suppose a firm provides you with the following information for the most recent period of operations: (a) Sales = 500 units; (b) Revenues = $15,000; (c) Variable manufacturing costs = $5,000; (d) Variable selling and administrative costs = $1,000; (e) Fixed manufacturing costs = $6,000, and; (f) Fixed selling and administrative costs = $2,000.

Required:

Calculate both the unit contribution margin and contribution margin, and prepare a contribution margin statement.

4.33 Contribution margin statement (LO1). The following is the income statement from Ajax Corporation, a merchandising firm.

Ajax Corporation Income Statement for the Most Recent Year	
Revenue	$1,525,000
Cost of goods sold	900,000
Transport in	24,500
Gross margin	$600,500
Administration costs	220,000
Selling costs	240,000
Profit	$140,500

You learn that $18,000 in transport in represents fixed costs, and Ajax pays its sales persons a commission of 6%. That is, a person selling $1,000 worth of items would earn a commission of $60.

Required:

Prepare an income statement in the contribution margin format.

4.34 Contribution margin statement (LO1). Jindal Manufacturing Company provides you with the following income statement.

Jindal Manufacturing Company Income Statement for the Most Recent Year	
Revenue	$2,435,000
Cost of goods sold	1,246,760
Gross margin	$1,188,240
Administration costs	425,000
Selling costs	558,950
Profit	$204,290

You learn that Jindal incurred manufacturing overhead costs of $248,750 for the year and that all of this cost is fixed. Moreover, the only variable selling costs are sales commissions at 5% of revenue. Finally, all administration costs are fixed.

Required:

Prepare an income statement in the contribution margin format. For simplicity, assume that the Jindal began and ended the year with zero inventories of any kind.

4.35 Cost estimation: Account classification (LO2). Dean Previts is considering increasing the number admitted into an MBA program from 400 to 450. He anticipates that the increase will add eight sections in total. Staffing ratios have usually run about 1 staff person per 50 students.

Required:

Using account classification, estimate the increase in the following costs because of the decision to increase enrollment.

Student related variable costs	$2,500 per student per year
Faculty related costs	$150,000 per faculty member.

Each professor teaches four sections per year.

Administration costs	$60,000 per full time employee
Building maintenance	$150,000 per year

4.36 Cost estimation: Account classification (LO2). Mega Manufacturing is considering whether to increase the production of one of its products, the Mega Rototiller. The product has done better than expected, and management wishes to figure out the costs of increasing production (and sales) from 10,000 units to 12,500 units per month.

The following data pertain to the current production of 10,000 units per month.

Number of Units	*10,000*	*Detail*
Materials and components	$120,000	Traced
Direct labor	115,000	Traced
Supplies	11,500	Determined as 10% of labor cost
Oils and lubricants	4,500	At $1.50 per machine hour
Machine depreciation	67,500	At $22.50 per machine hour
Plant heating and lighting	20,000	Based on area occupied
Plant rental	12,000	Based on area occupied
Freight out	2,500	Actual cost
Sales commissions	20,000	At 4% of sales revenue
Sales office administration	25,000	Allocated based on sales $
Corporate office costs	2,400	Allocated based on head count
Total product cost	$400,400	

Required:

Determine the expected increase in costs if Mega decides to produce 12,500 units per month. This increase would last for two months, and then Mega would revert to its production level of 10,000 units per month. Be sure to consider the nature of the cost and its controllability in your answer.

4.37 Cost estimation: Account classification (LO2). MidWest University offers executive MBA programs in Singapore. The dean has charged you with estimating the cost of offering the program. You identify the following:

Item	*Detail*
Tuition revenue	$35,000 per participant. 40 participants expected.
Partner fee	The partner in Singapore takes 35% of revenue. In return, the partner provides all marketing, student recruitment, local logistics, and classrooms.
Instructor costs	$20,000 paid as salary to instructor. Travel reimbursed on actual cost basis, averaging $4,500 per trip. The program comprises 16 classes.
Textbooks, copies, and so on	These costs amount to $200 per student per course.
Administration costs	Between them, the dean and the associate dean make three trips costs per year (cost: $6,500 per trip). They also estimate that the work at the U.S. location accounts for 1.5 full-time equivalent (FTE) employees (average salary: $54,000). The dean estimates that she spends 5% of her time on this program and the associate dean spends 10% of his time on the program. The dean earns $350,000, and the associate dean $225,000 per year.

Required:

a. Prepare a statement that shows (a) the contribution margin, (b) the program margin, and (c) the profit margin (after including allocated costs) for the Singapore program. Identify decisions for which (a) the contribution margin would be the focus and (b) the program margin is the relevant amount.

b. A local firm in Singapore has offered to enroll three of its managers in the program but only if the program reduces the fee to $25,000 per participant. Estimate the net increase in profit if the university accepts this offer.

4.38 Cost estimation: High-low method (LO3). Silk Flowers & More is an on-line company that specializes in selling silk flower arrangements, offering their customers free shipping on all orders. Management currently is interested in understanding how shipping costs vary with the number of flower arrangements sold. To this end, they have provided you with the following data for the most recent five months of operations:

Month	*Flower Arrangements Sold*	*Shipping Costs*
January	5,000	$27,500
February	7,500	$33,750
March	6,000	$30,250
April	6,500	$31,000
May	7,000	$32,375

Required:

a. Use the high-low method to estimate Silk Flowers & More's monthly shipping cost equation.

b. Assume Silk Flowers & More expects to sell 5,500 flower arrangements in June. Use the cost equation you developed in part (a) to estimate Silk Flowers & More's June shipping costs.

c. Discuss why management of Silk Flowers & More would want an estimate of the cost equation for monthly shipping costs.

4.39 Cost estimation: High-low method (LO3). Ginsburg and Company provide you with the following data:

Month	*Supervision Cost*	*Labor Hours*	*Machine Hours*
January	$27,500	2,400	5,040
February	$27,500	2,560	5,300
March	$32,540	3,360	6,600
April	$30,000	2,880	6,500
May	$32,630	3,300	6,750

Required:

a. Use the high-low method to estimate Ginsburg's monthly fixed supervision cost and the cost per labor hour. (i.e., assume Ginsburg uses labor hours as its measure of activity).

b. Use the high-low method to estimate Ginsburg's monthly fixed supervision cost and the cost per machine hour (i.e., assume Ginsburg uses machine hours as its measure of activity).

c. Which of the two estimates, the answer to question (a) or question (b), is likely to be more representative of actual cost behavior?

d. Why might a manager believe that neither equation is a good way to estimate supervision costs?

4.40 Cost estimation: High-low method, decision making (LO3, LO1). Frame & Show is the name Megan Dee selected for her custom framing shop. Megan opened Frame & Show two years ago and has seen a steady improvement in her business. Megan's customers really seem to appreciate the extensive range of moldings and mat boards Frame & Show offers as well as Megan's artistic talents in frame design. Condensed income statements for Frame & Show's first two years of operations follow:

	Year 1	*Year 2*
Number of items framed	3,000	3,500
Total revenue	$318,000	$371,000
Total costs	$310,000	$332,500
Profit before taxes	$8,000	$38,500

Both the average frame price and Megan's cost structure have remained the same during Frame & Show's first two years of operations and Megan believes they are likely to remain the same in the near future.

Required:

a. Use the high-low method to estimate Frame & Show's annual cost equation (i.e., use the data from years 1 and 2 to estimate Frame & Show's annual fixed costs and variable cost per framing).

b. Megan has been asked to participate in the local "Thieves Market." If she decides to participate in the market then, in addition to the variable cost of each framing, Megan will have to pay a booth fee of $2,500 to the sponsors. Megan estimates that, above and beyond her normal business, she will also be able to sell 150 framings at the market. By how much is Frame & Show's profit expected to change if Megan participates in the Thieves Market?

4.41 Regression method for estimating the cost equation (LO4). Refer to the previous exercise, Silk Flowers & More.

Required:

a. Use the regression method to estimate Silk Flowers & More's monthly shipping cost equation.

b. Assume Silk Flowers & More expects to sell 5,500 flower arrangements in June. Use the cost equation you developed in part (a) to estimate Silk Flowers & More's June shipping costs.

4.42 Regression method for estimating the cost equation: Interpreting regression output (LO4). The GPS Company is trying to derive a cost equation that predicts its monthly materials-handling costs. GPS estimated the following two equations using regression analysis.

Equation 1:
Materials-handling costs per month = $24,543.34 + ($0.027 × value of materials handled)
R-square = 54.17%
Both coefficients have *p*-values of 0.05 or lower.

Equation 2:
Materials-handling costs per month = $12,452.56 + ($10.45 × number of material moves)
R-square = 76.34%
Both coefficients have *p*-values of 0.01 or lower.

Required:

Which of these two equations do you believe better predicts GPS's monthly materials-handling costs? Why?

4.43 Regression method for estimating the cost equation: Interpreting regression output (LO4). O'Conner and Company provide you with the following data regarding their transportation costs.

Month	*Number of Cases Shipped*	*Total Costs*
January	1,200	$13,750
February	1,440	$15,500
March	1,680	$16,250
April	2,100	$17,000
May	2,400	$17,500
June	2,640	$18,500
July	2,880	$20,000
August	3,000	$20,313
September	2,400	$18,125
October	1,920	$16,250
November	1,500	$15,000
December	1,320	$21,250

Required:

a. Using regression analysis, estimate O'Conner's monthly fixed costs and the cost per case shipped.

b. Evaluate the goodness of fit of the regression equation.

4.44 Organizing information for decision making: Creating a product contribution margin statement (LO5). Caylor Company is a biotechnology firm that specializes in developing drugs based on monoclonal antibodies. The firm has obtained FDA approval for two drugs: RX-560 and VR-990. RX-560 is a recent approval and commands a premium price. In contrast, competition from superior formulations and from generic drugs is eroding the market for VR-990.

The firm provides you with the following information from its most recent income statement. While the income statement conforms to Generally Accepted Accounting Principles, management wishes to redo the income statement to provide better information for making product-level decisions.

Caylor Company
Income Statement for the Most Recent Year

Revenues	$17,400,000
Cost of goods sold	4,840,000
Gross margin	$12,560,000
Selling, general and administrative (SG&A) expenses	12,270,000
Profit before taxes	$290,000

You also collect the following product-specific information:

	RX-560	*VR-990*
Number of doses sold	180,000	2,000,000
Price per dose	$30	$6
Variable manufacturing cost per dose	$3	$1
Variable SG&A cost per dose	$4	$4
Traceable fixed manufacturing costs	$500,000	$500,000
Traceable fixed SG&A costs	$1,000,000	$1,350,000

Finally, you determine that Caylor spent a total of $2,500,000 on fixed costs common to both products (i.e., the $2,500,000 is not directly traceable to either product). Of this amount, Caylor spent $1,300,000 on manufacturing costs and the remaining $1,200,000 on SG&A costs.

Required:

a. Create a product-level contribution margin statement for Caylor Company.

b. How might Caylor use the product contribution margin statement to make better decisions?

4.45 Organizing information for decision making: Creating segmented contribution margin statements (LO5). The Omega Corporation sells two different lines of bathroom fixtures: standard and deluxe. Omega began its operations in the eastern part of the United States and recently expanded its operations to the western United States.

Omega has provided you with the following monthly sales and variable cost data by product and geographical region:

	Revenue per Month		*Variable Manufacturing Costs**	*Variable Selling Costs**
Product	*Eastern Region*	*Western Region*		
Standard	$1,000,000	$400,000	55%	3%
Deluxe	$1,000,000	$200,000	75%	2%

* As a percentage of sales revenue.

In addition to the above information, you find that Omega currently spends $750,000 each month on fixed costs. By geographical region, $250,000 of the $750,000 is traceable to the Eastern region and $225,000 is traceable to the Western region. The remaining $275,000 is not traceable to either region. By product, $275,000 of the $750,000 is traceable to the Standard line, whereas $225,000 is traceable to the Deluxe line. The remaining $250,000 is not traceable to either product.

Required:

a. Create a monthly contribution margin statement by geographical region (Eastern and Western) for the Omega Corporation.

b. Create a monthly contribution margin statement by product (Standard and Deluxe) for the Omega Corporation.

c. How might the contribution margin statements you created in parts (a) and (b) assist Omega's management in making better decisions?

4.46 Learning curves (Appendix). Atman Enterprises assembles satellites using customer-supplied parts and materials. A customer has asked Atman to bid on a new model of satellites and estimates purchasing eight units. Atman believes that it would take 20,000 hours to assemble the first satellite. Atman's labor cost is $25 per labor hour.

Required:

a. Determine the total number of hours required to assemble all eight satellites, assuming no learning takes place. What is the associated labor cost?

b. Repeat requirement (a) assuming that Atman expects to realize a 90% learning curve for such jobs.

c. Comparing your answers for parts (a) and (b), what conclusions do you draw about the importance of including the effects of learning when bidding for jobs?

PROBLEMS

4.47 Cost estimation: Hierarchical cost structure and account classification (LO1, LO2). When she was a child, Amy Nicholson spent a lot of time in Southeast Asia. Consequently, Amy is well versed in the local languages (she is fluent in Thai and Tagalog) and customs. Over time, Amy has parlayed her experience and expertise into a profitable business: she organizes tours to Southeast Asia for vacation travelers from North America. Not surprisingly, Amy's profit depends a great deal on the number of tours she organizes. Amy charges $4,000 per person and can accommodate a maximum of 50 persons per tour. While she seeks to fill up each tour, some tours have less than 50 persons. Amy cancels the tour if she has fewer than 35 persons. Amy estimates that each tour costs $98,000 to set up and organize. This cost is in addition to the variable cost of $1,200 she incurs for each person on the tour. Finally, Amy incurs fixed expenses of $50,000 per quarter to maintain her central office in Carmel-by-the-Sea, California.

Required:

a. Classify each of Amy's three types of costs (cost per person, per tour, and per quarter) as per the cost hierarchy.

b. Using your cost classifications from part (a), calculate Amy's total quarterly costs if (1) she has two tours with 40 persons per tour, and (2) she has five tours with 50 persons per tour.

c. Why would Amy cancel a tour if it has fewer than 35 persons?

4.48 Cost estimation: Account classification, allocations (LO2, Advanced). Shringar Industries is a leading manufacturer of cosmetic products. The following data concern one of the firm's products:

	Sales Volume	
Item	*10,000 units*	*12,000 units*
Direct materials	S2.50	$2.50
+ Direct labor	2.14	2.14
+ Departmental overhead: Direct	0.45	0.45
+ Departmental overhead: Indirect	3.10	2.58
+ Factory overhead	2.14	2.14
= Factory cost	10.33	9.81
+ Selling & administration overhead	3.62	3.43
= Total cost per unit	$13.95	$13.24

You know that Shringar allocates factory overhead based on labor cost and that the charge for selling and administration cost is 35% of factory cost. Digging deeper, you learn that direct departmental overhead comprises supplies and other consumables. The indirect overhead is traceable to the product as it represents the cost of direct supervision.

Required:

Shringar has been producing 10,000 units per month. Suppose, for the next month alone, the firm wishes to increase its level of production from 10,000 to 11,500 units per month. Determine the controllable costs the firm should use for this decision. That is, what is the cost of increasing production by 1,500 units?

4.49 Cost estimation: Account classification and hierarchical cost structure, decision making (LO1, LO2). Comfort Pillows makes "ultra-luxury" goose-down pillows encased in 500-thread count fabric. In recent years, Comfort Pillows has operated at only 60% of its available capacity. Spooked by market volatility, many persons in Comfort Pillows' target market have scaled back on ostentatious purchases. As a result, the firm currently is producing only 12,000 pillows per month rather than the 20,000 pillows it could produce. Comfort Pillows makes its pillows using labor paid on an hourly basis. While machine capacity is difficult to adjust in the short term, it is easy to adjust the amount of labor.

Seeking to make gainful use of its machine capacity, Comfort Pillows is considering an order from a high-end department store. The department store wants Comfort to make 5,000 pillows. The department store will sell the pillows under its own brand name. Comfort Pillows has asked you to analyze its accounts and prepare a price estimate. The firm plans to arrive at its selling price by adding a 25% markup to the controllable costs associated with accepting the order. The following data are available:

Item	Cost
Fabric	$2.50 per pillow
Fill	$18.00 per pillow
Industrial sewing machines	1/2 hour per pillow; the long-term lease cost is $100,000 per year; Comfort Pillows has enough sewing machines to produce 20,000 pillows per month.
Labor	1/2 hour per pillow; labor costs $12 per hour.
Plastic wrap & other packing	$0.50 per pillow
Cartoning & crating	$10.00 per 25 pillows.
Transportation	$1,500 for a truckload of 2,500 pillows
Purchasing & manufacturing support	$32,500 for 12,000 pillows per month. Comfort expects this cost to increase by $15,000 per month (to $47,500 per month) if volume increases to 15,000 or more pillows per month.
Advertising brochures	$150,000 per year
Office expenses	$300,000 per year. The current office staff can support a volume of 20,000 pillows per month.
Sales & customer support	$200,000 per year for 250 customers. The department store is not a regular customer. Comfort expects to spend a total of $1,000 in arranging logistics and incorporating the department store into its regular client list.

Required:

a. Classify each of the cost items as being controllable (C) or noncontrollable (NC) for pricing the department store's order. Next, calculate the price per pillow, assuming Comfort Pillows adds a 25% markup to the controllable costs associated with accepting the order.

b. What is the price per pillow if the department store's order is for 4,000 pillows?

4.50 Cost estimation: High-low method, relevant range (LO3). Although only open for one year, Pizzeria Paradise has established a reputation as serving excellent deep-dish pizza and recently won a "Best of City" award. Management is interested in using the data from the first year of operations to estimate the firm's cost structure. To this end, they have provided you with the following data for the first four quarters of operations:

Quarter	*Number of Pizzas Sold*	*Total Costs*
First	25,000	$115,000
Second	30,000	$150,000
Third	35,000	$175,000
Fourth	40,000	$190,000

Required:

a. Use the high-low method to estimate Pizzeria Paradise's quarterly cost equation (i.e., use the high-low method to estimate Pizzeria Paradise's quarterly fixed costs and variable cost per pizza).

b. How would you interpret the estimate of fixed costs if it were below zero?

c. Use the cost equation you developed in part (a) to predict Pizzeria Paradise's total quarterly costs for a volume of 50,000 pizzas. How confident are you in your estimate of total quarterly costs?

4.51 Cost estimation: High-low method, relevant range (LO3). Zap, Inc., manufactures and sells a broadleaf herbicide that kills unwanted grasses and weeds. Via their television commercials, Zap encourages homeowners to "take control of their yard" by purchasing one of their "ZAP" kits for $39.95. Each "ZAP" kit includes a 32-ounce bottle of weed and grass killer concentrate and a 16-ounce bottle of poison ivy and tough brush killer concentrate. A review of the firm's production and cost data for the previous four quarters revealed the following:

Quarter	*ZAP Kits Sold*	*Total Costs*
First	5,400	$187,800
Second	9,600	$268,200
Third	6,000	$192,000
Fourth	4,500	$181,500

Required:

a. Use the high-low method to estimate Zap's quarterly cost equation (i.e., use the high-low method to estimate Zap's quarterly fixed costs and variable cost per ZAP kit sold).

b. Using the four data points provided, graph Zap's total costs (*y*-axis) as a function of the number of ZAP kits sold (*x*-axis). Does any particular data point strike you as being unusual?

c. Since the data point for the second quarter appears to be "different" from the other data points, you decide to ask management whether anything unusual occurred in this quarter. Management informs you that, similar to prior years, the firm runs extra advertising in the second quarter, just before the peak summer months when weeds are most active. How does this information affect your analysis? Reestimate Zap's quarterly cost equation, ignoring the data from the second quarter. Use this new cost equation to estimate the amount Zap spent on extra advertising during the second quarter.

d. What inferences do you draw about graphing the data and ensuring data validity before estimating a firm's cost structure?

4.52 Cost estimation: Step costs, multiple cost drivers (LO2, LO3; Advanced). Carlton Stokes owns and operates a car-detailing business named "SuperShine & Detailing." For $150, Carlton's business will hand wash and wax customers' cars, vacuum the interior, and thoroughly clean the upholstery, wheels, tires, and windows. In addition, Carlton's business will pick up each customer's car in the morning and return it to the customer's workplace or home, as instructed.

Buoyed by the success of his first shop, Carlton plans to expand his business to another location. Similar to his current location, Carlton is committed to using only full-time employees at the new location. As his business expands, Carlton believes it will become increasingly important to understand his cost structure. To this end, he seeks your help in estimating his fixed costs, the variable cost of detailing a car, and the annual cost per employee. Carlton has provided you with the following data for the most recent three years of operations at his present location:

Year	*Cars Detailed*	*No. of Employees*	*Total Costs*
1	1,200	2	$129,000
2	1,600	2	$137,000
3	2,400	3	$183,000

Carlton believes that his cost structure has not changed over the last three years and that one employee, working diligently, can detail three cars per day. SuperShine & Detailing is open for business 300 days a year.

Required:

a. How does the cost of employees vary with the number of cars detailed? Is the cost of employees a fixed cost, a variable cost, or a step cost? Why?

b. Using the data provided, estimate Carlton's annual fixed costs, the annual cost per employee, and the variable cost per car detailed. (*Hint:* Notice that two of the three years have the same number of employees.)

4.53 Cost estimation: Contrasting high-low and account classification methods (LO2, LO3; Continuation of Comfort Pillows). As an alternative to the detailed account analysis, management at Comfort Pillows desires to use the high-low method to estimate the variable cost associated with producing a pillow. The firm plans to add 25% to the variable cost to arrive at the price charged to the department store. Management of Comfort Pillows has provided you with the total costs associated with the highest (September) and lowest (March) monthly production volumes for the most recent year of operations.

Month	*Pillows Sold*	*Total Costs*
March	10,000	$420,000
September	15,000	$560,000

Required:

a. Use the high-low method to estimate Comfort Pillows' monthly cost equation (i.e., use the high-low method to estimate Comfort Pillows' monthly fixed costs and variable cost per pillow produced).

b. Using the variable cost estimate, calculate the price per pillow that Comfort will charge the department store.

c. Explain why your answer to part (b) above differs from your answer to part(a) in the previous problem. Which of these two estimates do you believe is better/more reliable? Why?

4.54 Regression method for estimating the cost equation (LO4). Watson College includes the cost of all textbooks, lab supplies, and course packets in its tuition. Facing increasing financial pressures, Watson College is interested in predicting the costs associated with copying class notes (i.e., making course packets for students). Watson's vice president of finance has provided you with the following data regarding the total costs of printing course packets, and the corresponding class size for six representative classes:

Class Size (Students)	*Total Costs of Making Course Packets for the Class*
10	$175
20	$225
30	$268
40	$290
50	$345
60	$370

Required:

a. Plot the relation between the total cost of making course packets for a class (y-axis) and class size (x-axis). Does the relation between the cost of making course packets and class size appear to be linear?

b. Using Excel, fit a regression line to Watson College's course packet data. What are the fixed costs per class associated with preparing a course packet, and what is the variable cost per student?

c. Comment on the results. Does the regression line appear to "fit" the data? How might the vice president further increase the accuracy of the cost estimate?

4.55 Regression method for estimating the cost equation: Matching time periods (Advanced, LO4). Frank Fletch manages a plant that produces a variety of ball bearings and cylindrical roller bearings. Seeking to better understand his cost structure, Frank collected the following data regarding the number of machine hours worked and the number of maintenance hours for the past nine quarters (2.25 years) of operations:

Quarter	*Machine Hours*	*Maintenance Hours*
Q1, 2007	10,000	810
Q2, 2007	12,200	655
Q3, 2007	13,400	886

Quarter	*Machine Hours*	*Maintenance Hours*
Q4, 2007	15,300	971
Q1, 2008	12,000	1,041
Q2, 2008	13,500	700
Q3, 2008	15,000	814
Q4, 2008	18,000	966
Q1, 2009	12,250	1,203

Required:

a. Using Excel, estimate the following regression equation: *Maintenance hours* = *FC* + (*UVC* × machine hours).

b. Why do you believe that the equation you developed in part (a) does not predict the number of maintenance hours worked in a quarter? You know that Frank usually schedules preventive maintenance during "off" times when the machines are not being fully utilized.

c. Modify the equation in part (a) so that maintenance hours are regressed on machine hours from the prior quarter. That is, estimate the following regression equation: *Maintenance hours* = *FC* + (*UVC* × machine $\text{hours}_{\text{quarter-1}}$).

4.56 Regression method for estimating the cost equation: Specification issues (LO4, Advanced). PermaPictures uses computer-guided lasers to etch pictures from photographs on granite. The firm's management advertises heavily because it believes that advertising and product recognition is a key factor in generating sales. The following data pertain to the previous eight quarters of operations:

Advertising Costs	*Sales Revenue*
$200,000	$1,235,000
$225,000	$1,369,000
$240,000	$1,403,000
$275,000	$1,408,000
$180,000	$1,132,000
$220,000	$1,212,000
$210,000	$1,260,000
$230,000	$1,345,450

Required:

a. Plot the relation between advertising costs (*y*-axis) and sales revenue (*x*-axis). Does the relation between advertising costs and sales revenue appear to be linear?

b. Using Excel, estimate the following regression equation: *Advertising Costs* = *Fixed costs* + (*UVC* × *Sales Revenue*). That is, use sales revenue as the cost driver for advertising costs.

c. Using the regression equation you developed in part (b), estimate PermaPictures' advertising costs for a sales volume of $1,750,000. Comment on the validity of this estimate and, more generally, on the validity of the underlying cost equation being estimated. (*Hint:* Consider whether it is sensible to specify advertising costs as a function of sales revenue.)

4.57 Organizing information for decision making: Assessing segment contributions (LO5). Carousel Motors is an auto dealership that specializes in selling used cars. Carousel also has a small service station that it uses to (1) make minor repairs on the cars it buys and (2) provide both paid and courtesy repairs and maintenance on customers' cars. For example, Carousel often runs ads that offer "free maintenance for one year with any auto purchase," and restricts the maintenance to regularly scheduled items such as oil changes and tire rotations. The following data pertain to Carousel's most recent year of operations:

	Used Cars	*Service Department*	*Total*
Revenue	$2,500,000	$200,000	$2,700,000
Variable costs	1,200,000	200,000	1,400,000
Contribution margin	$1,300,000	$0	$1,300,000
Traceable fixed costs	750,000	250,000	1,000,000
Segment margin	$550,000	($250,000)	$300,000
Common fixed costs			200,000
Profit before taxes			$100,000

* Common fixed costs equal the salary of the owner plus the salary of the general manager.

You are puzzled by the service department's zero contribution margin since you know that the service department marks up its variable cost by 100% to arrive at the price charged to an external customer. Digging into the data, you learn that the service department only spent one-half of its time servicing external customers. The remainder of its time was spent repairing cars bought to replenish Carousel's inventory of used cars and providing courtesy (free) repairs on the used cars sold. For the service department, the above income statement only shows the revenues derived from sales to external customers, while it shows the costs associated with all of its service activities. Moreover, the used car division does not record any costs for the repairs provided by the service department.

Required:

a. Modify Carousel's contribution margin statement so that the service department's revenues and the used car's costs fully reflect the market value of the services provided by the service department to the used car department (i.e., assume that the service department charges used cars what it charges external customers). (*Hint:* Carousel's overall profit before taxes will not change.)

b. Jim Carew, the owner of Carousel Motors, believes that closing the service department will increase overall company profit. Based on your calculations in part (a), by how much will Carousel's overall profit increase or decrease if the service department is closed? (Assume that the used car department will pay an independent service station for the minor repairs on the cars it buys and for the courtesy repairs and maintenance on the used cars sold—all of this will be done at market price, or the amount you calculated in part [a].) What other factors should Jim consider before making the decision to close the service department?

c. Assume that closing the service department will reduce used car sales by 10%. How does this information affect your answer to part (b)? That is, by how much will Carousel's overall profit increase or decrease if the service department is closed and used car sales decrease by 10%? (Assume that the reduction in sales is not enough to affect used car's traceable fixed costs).

4.58 Learning curves and cost estimation (Appendix). FlyWell Avionics produces sophisticated guidance systems that are used in military satellites. FlyWell currently is bidding on a government contract to supply 32 specialized guidance systems over the next two years. FlyWell estimates that the variable cost of the first guidance system will be $1,200,000, which is comprised of $600,000 in labor costs, $400,000 in material costs, and $200,000 in variable overhead (i.e., other variable manufacturing) costs. While the materials and variable overhead costs are expected to remain constant over the 32 guidance systems, FlyWell believes that labor costs will be subject to a 90% learning curve. That is, as workers become familiar with producing the new guidance system, they are expected to become more efficient in performing their duties. Consequently, the average labor hours and, in turn, labor costs per guidance system are expected to decrease as the number of guidance systems produced increases.

On this particular government contract, management of FlyWell plans to submit a bid that equals the total variable costs of producing the 32 guidance systems plus a 50% markup (i.e., the bid = 1.50 × total variable costs).

Required:

a. What are the total variable costs FlyWell expects to incur in producing the 32 guidance systems?

b. What is the bid that FlyWell plans to submit? If it wins the contract, what is FlyWell's expected contribution margin from producing the 32 guidance systems?

c. Suppose that FlyWell obtains the contract but, due to budgetary pressures, the government is forced to scale back its order to 16 systems. Because the order size has been cut in half, the government is only willing to pay half of FlyWell's bid calculated in part (b). What is the actual contribution margin and markup that FlyWell will realize from this contract?

4.59 (Advanced) Learning curves and cost estimation (Appendix). Zeron, a medical equipment company, is expanding its product line and plans to manufacture testing equipment that calibrates magnetic resonance imaging (MRI) machines. Zeron plans to manufacture the MRI testing equipment in batches of 100 units. The firm estimates that the variable costs of producing the first batch will equal $1,000,000, which is comprised of $150,000 in materials costs, $50,000 in variable overhead costs, and $800,000 in labor costs ($800,000 = 32,000 labor hours × $25 per labor hour).

While the materials and variable overhead costs are expected to remain constant over time, Zeron believes that labor costs will be subject to a learning curve. Specifically, Zeron estimates that the second batch of 100 units will only consume 22,400 labor hours. Zeron plans to price the MRI testing equipment at the average variable cost to produce batches 17 to 32 plus a 75% markup (i.e., the unit selling price = 1.75 × average unit variable cost for units produced in batches 17 through 32).

Required:

a. What is the planned unit selling price of the MRI testing equipment? (Remember to adjust the batch cost to obtain a unit cost.)

b. What is the expected profit from the MRI testing equipment in year 1 if Zeron plans to produce 16 batches in the first year? Assume Zeron will incur fixed costs of $3 million per year to produce the MRI testing equipment.

c. What is the expected profit from the MRI testing equipment in year 2 if Zeron plans to produce batches 17–32 in the second year? Again, assume Zeron will incur fixed costs of $3 million per year to produce the MRI testing equipment.

MINI-CASES

4.60 Cost estimation: High-low method (LO3). The Yin-Yang Yogurt Shoppe serves the best chocolate-vanilla frozen yogurt in the city. While Yin-Yang's management tracks the cups of yogurt sold and total costs incurred each month, they are woefully unaware of which costs do and do not vary with the cups of yogurt sold (i.e., which costs are fixed and which costs are variable). Yin-Yang's management is hoping that you can figure out their cost structure. To this end, they have provided you with the following data for the past 12 months of operations:

Month	*Cups of Yogurt Sold*	*Total Costs*
January	1,000	$5,500
February	1,200	$6,200
March	1,400	$6,500
April	1,750	$6,800
May	2,000	$7,000
June	2,200	$7,400
July	2,400	$8,000
August	2,500	$8,125
September	2,000	$7,250
October	1,600	$6,500
November	1,250	$6,000
December	1,100	$8,500

Required:

a. Plot (i.e., graph) the relation between Yin-Yang's monthly total costs (*y*-axis) and cups of yogurt sold (*x*-axis).

b. Estimate Yin-Yang's monthly total cost equation using the data from January and February (i.e., use the data from January and February to estimate Yin-Yang's monthly fixed costs and variable cost per cup of yogurt sold).

c. Estimate Yin-Yang's monthly total cost equation using the two observations associated with the highest and lowest total monthly *cost* levels.

d. Estimate Yin-Yang's monthly total cost equation using the two observations associated with the highest and lowest total monthly *activity* levels (i.e., use the high-low method).

e. Estimate Yin-Yang's cost structure using regression analysis. Perform the analysis with and without the data for December.

f. Comment on the results. Specifically, which cost estimate do you believe is best? Why do you believe the estimate you chose leads to a better specification of Yin-Yang's monthly total costs than the other two estimates?

4.61 Cost hierarchy, cost estimation, decision making (LO1, LO2, LO3) Brad Timberlake is known throughout the world for his insights on effective and efficient time management.

Brad has authored several best-selling self-help books (also available in audio and video tape). In addition, Brad offers daylong seminars in major metropolitan areas. Brad has hired you (he does not have the time to do this himself!) to figure out if he should change the way he offers seminars.

Currently, Brad offers 35 daylong seminars each year at locations throughout North America, Europe, and Asia. The typical seminar is comprised of an initial talk followed by a break-out session in which participants complete worksheets that help them assess how they have been managing their time. After a coffee break, Brad critiques the "typical" worksheet and identifies the "time demons," as he calls time-wasting activities. The chastised participants adjourn for lunch. After lunch, Brad offers tips and solutions for better time management. Participants then go back to their break-out groups and redo their worksheets. The grand finale is a comparison of a pre- and post-time allocation sheet from a "random" participant.

Each seminar lasts the better part of a day. The average seminar has 125 participants, each of whom pays a $400 fee. The variable costs (folder, worksheets, copy of Brad's book, and food) amount to $75 per participant. In addition, setting up the seminar itself (the use of a hotel or convention center, hotel staff, and Brad's travel expenses—he always travels first class) costs $20,000 per seminar. Finally, Brad pays a coordinator a salary $50,000 per year to organize his seminars and incurs $250,000 in fixed costs annually to maintain a central office and support staff.

The following table provides summary data for Brad's seminars for the most recent four years (starting with the most recent year):

	Year 4	*Year 3*	*Year 2*	*Year 1*
Number of seminars	35	40	28	30
Total number of participants (number of seminars × 125)	4,375	5,000	3,500	3,750
Total revenues (number of participants × $400)	$1,750,000	S2,000,000	$1,400,000	$1,500,000
Total costs	1,328,125	1,475,000	1,122,500	1,181,250
Profit before taxes	$421,875	$525,000	$277,500	$318,750

Brad is getting tired of the endless travel and is considering offering fewer seminars. In particular, Brad wants to do no more than 20 seminars per year. To keep up with demand (and to try to keep his profit at the same level), Brad plans to increase the size of each seminar so that the average seminar has 230, rather than 125, participants. Because each participant would receive less personal attention, Brad also plans to reduce his seminar fee from $400 to $350 per person.

Required:

a. Brad wishes to use the high-low method to estimate his annual fixed costs and variable cost per seminar participant. That is, Brad wishes to represent his total annual costs as: Total costs = Fixed costs + (Variable cost per seminar participant × Total number of seminar participants). Using the data from the past four years, estimate Brad's annual fixed costs and variable cost per participant under the high-low method.

b. Using the cost equation you derived in part (a), what is Brad's estimated annual profit associated with offering 20 seminars under the proposed format (i.e., 230 participants per seminar, with each participant being charged $350)? How does this profit compare to Brad's current profit (i.e., 35 seminars under the current format)?

c. Not satisfied with your answer to part (b), Brad wants to dig a little deeper into the problem. On one of his trips, Brad learned about the cost hierarchy. (Brad excels at multitasking!) He asks you to classify each of his four types of costs (i.e., the variable cost per participant, seminar costs, coordinator's salary, and central office) as per the cost hierarchy.

d. Your classification of Brad's costs vis-à-vis the cost hierarchy leads you to reconsider your analysis in part (b). Taking a closer look at Brad's costs, you learn that the change in the seminar format would not affect the per-participant variable cost, the seminar coordinator's salary, or Brad's central office costs. However, because of the increased enrollment, the cost of hosting each seminar would increase by $5,000 (i.e., from $20,000 to $25,000 per seminar). Using your knowledge of the cost

hierarchy, what will Brad's profit be if he switches to the new seminar format? That is, use the account classification method to estimate Brad's profit associated with offering 20 seminars under the proposed format.

e. Do your answers from parts (b) and (d) differ? If so, why?

4.62 Cost estimation, sunk costs, decision making (LO1, LO2, LO3). Molly's Music is an independent record store located in Seattle, Washington. Molly, a self-described "music junkie," started her business after she encountered repeated difficulties finding music that was not produced by one of the major record labels. Molly wanted a store that had just about everything in stock, from the most popular artists to the most obscure artists in all musical genres, be it rock or roots. She also wanted a store that supported local musicians by carrying their CDs.

Albeit slowly, Molly has seen her business grow over the years and, on any given day, Molly's 25,000 square-foot store has 75,000 titles in stock. Molly also has assembled an eclectic, knowledgeable staff that lives for music and can assist customers with just about any musical question or request. A review of Molly's sales, costs, revenue, and profit data for the previous 12 months revealed the following:

Month	*CDs Sold*	*Total Costs*	*Revenue*	*Profit*
January	8,500	$145,675	$144,075	($1,600)
February	8,000	$142,500	$135,600	($6,900)
March	8,800	$144,590	$149,160	$4,570
April	10,800	$162,880	$183,060	$20,180
May	7,900	$138,425	$133,905	($4,520)
June	7,000	$128,000	$118,650	($9,350)
July	9,500	$150,100	$161,025	$10,925
August	6,000	$125,000	$101,700	($23,300)
September	10,000	$151,305	$169,500	$18,195
October	9,600	$157,875	$162,720	$4,845
November	8,800	$147,500	$149,160	$1,660
December	12,000	$170,000	$203,400	$33,400
Total:	106,900	$1,763,850	$1,811,955	$48,105

While you find Molly's proceeds from her business impressive, you believe that she could do better if she reduced the average selling price per CD. Specifically, over the past several years, you (as one of Molly's employees) have heard numerous customers rave about Molly's knowledgeable and courteous staff and vast array of CD titles. However, you also have heard numerous customers say that Molly's average price of $16.95 per CD is "unreasonable." Moreover, you have witnessed individuals come into the store, ask for your advice, and then leave without making a purchase. Your supposition is that once these customers decide on the CDs they want, they actually buy their CDs from one of the local chain stores where the average price per CD is $14.95.

To be competitive with the chain stores, you believe that Molly should reduce the average selling price of a CD by $2.00 to $14.95. Based on your experience and an informal customer survey, you estimate that such a move would increase CD sales by 30%. You also believe that the increased sales volume would be well within Molly's relevant range—that is, if sales increased by 30% Molly would not have to invest in additional fixed costs related to space, equipment, or personnel.

Molly believes that your idea is "nuts" because your recommended selling price is lower than the average cost per CD. Molly calculates that she would lose $14.95 − $16.50 = ($1.55) per CD if she followed your advice. Molly arrived at the $16.50 cost per CD by dividing her total costs for the most recent year, or $1,763,850, by the total number of CDs sold during the most recent year, or 106,900.

Required:

a. Before performing any calculations, prepare a brief paragraph or two discussing the soundness of Molly's logic regarding her response to your suggested price decrease.

b. Help Molly better understand the "big picture" by plotting (i.e., graphing) the relation between her total costs and number of CDs sold (x-axis). Is this graph informative about Molly's cost structure?

c. Using the high-low method, estimate Molly's monthly cost equation (i.e., use the high-low method to estimate Molly's monthly fixed costs and variable cost per CD

sold). Add a line representing Molly's estimated cost equation to your graph in part (b). Does your model appear to fit the data well?

d. Based on the cost model you developed in part (c), does it make sense for Molly to lower the selling price per CD to $14.95? That is, by how much do you estimate that Molly's expected yearly profit will increase or decrease if she follows your advice?

e. Molly is impressed with your business acumen and wonders whether the cost model you developed can help her with another business decision. Specifically, Molly is considering hiring another employee at a total cost of $52,150 per year in salary and benefits. Molly believes that this employee, who is an expert in international folk music, will increase monthly sales by 750 CDs. Assuming Molly decides to reduce the average price of a CD to $14.95, by how much is Molly's annual profit expected to increase or decrease if she hires this employee?

f. Molly has one final question for you. Ten years ago, she purchased 10 "Greatest Hits from the 70's" CDs (Molly was a huge fan of KC and The Sunshine Band, and they are featured on the CD's cover). Molly paid the record company $5 for each CD and priced them at $12.95 each. Molly sold six "Greatest Hits from the 70's" CDs in the first three years after acquiring them; however, Molly has not sold any of the remaining four CDs in the last seven years (the CDs have been sitting on the shelf collecting dust). Recently, one of Molly's college-age customers offered to buy the four remaining CDs for $15. (The customer thinks they will make nice gifts for his older relatives.) Molly is reluctant to accept the offer because she paid $5 for each CD. Before declining, though, she asks you for your advice. What would you recommend to Molly? Why?

4.63 Organizing information for decision making: Creating a customer contribution statement (LO5). Denzel Adams runs a carpet cleaning business in Tupelo, Mississippi. Denzel serves two major types of customers: motels and residential homes. Currently, Denzel spends three days each week cleaning the carpets and upholstery in six motels. He devotes the remaining two days of each week to cleaning the carpets and upholstery of individual residences. Denzel has asked for your help in determining whether he should drop his motel customers and focus solely on residences. Although he likes the steady business the motels provide, he does not like the price—Mina Patel, the owner of the six motels, drives a hard bargain.

You gather the following additional information about Denzel and his business:

- Denzel works 50 weeks a year. He works 10 hours a day Monday through Wednesday, the days he cleans the motels. He works an average of 6 hours a day on Thursday and Friday, the days he cleans residential homes. Denzel does not work weekends. Denzel values his work time at $15 per hour.
- Denzel receives $150 in revenue for each motel he cleans and $80 (on average) in revenue for each house he cleans. Denzel cleans two motels per day on Monday through Wednesday and three houses per day on Thursday and Friday.
- Denzel uses a higher grade cleaner for residences than motels. Denzel figures that he spends $20 in supplies per residential customer and $30 in supplies per motel. Denzel leases his van and other equipment for $7,000 per year. Of this, $1,500 worth of equipment is used only for the motel cleaning jobs.
- Denzel takes out ads in the local newspapers and yellow pages to drum up residential business. (Denzel does not incur advertising costs related to the motels since he's had the motel business for years.) He estimates this cost at $5,000 per year.
- Because he is under contract, Denzel needs to hire another company to clean the motels during the two weeks that he is on vacation (this company does not clean any residences for Denzel during these two weeks). While Denzel still receives the $150 fee per motel, he pays the other cleaning company a flat wage of $175 per motel (the other company uses its own supplies and employees to do all the work).
- Denzel works out of his home and uses his kitchen table as his office. He figures that he spends about $500 a year on supplies and $1,000 on telephone expenses. (These expenses cannot be directly traced to either motels or residences.)

Required:

a. Create an annual contribution margin statement by customer (motels and residences) for Denzel. (Be sure to include $15 per hour for Denzel's time.)

b. Based on your analysis, should Denzel drop his motel clients? Assume that if he drops the motel business, Denzel can double his residential business if he also doubles his advertising budget. (Be sure to consider the value of any savings in Denzel's time.)