

# THE COST-VOLUME-PROFIT APPROACH TO DECISIONS

## I N T R O D U C T I O N

This chapter introduces the cost-volume-profit (CVP) method, which can assist management in evaluating current and future events regarding sales revenue inflow and cost outflows. A number of basic questions will be identified and discussed using examples to explain CVP analysis.

A graphical explanation and presentation of CVP is then given, showing how the breakeven level of sales revenue can be determined and how the level of operating income (profit) for a particular volume of sales can be arrived at.

Before discussing and illustrating the CVP equation (which eliminates the need for a graph), several specific key assumptions and limitations inherent in the CVP approach will be addressed. The equation is used to determine the breakeven level of

sales revenue, the sales revenue needed to cover a new fixed cost, the additional sales revenue required to cover a changed variable cost, or multiple changes in costs. The CVP answers can be obtained in sales revenue dollars or sales end units, such as rooms sold or guests served.

The CVP equation can also be used to determine the effect that a change in selling prices will have on operating results to determine additional sales volume required to cover a loss, or to analyze a new investment.

This chapter illustrates how the CVP equation can be used to handle various situations concerning joint costs in multiple-department organizations and concludes with a discussion on incorporating income tax in the CVP calculation.

## CHAPTER OBJECTIVES

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After studying this chapter, the reader should be able to

- 1** Briefly discuss the assumptions and limitations inherent in CVP analysis.
  - 2** Identify and discuss the various functions shown in a graph of sales levels, and fixed and variable costs.
  - 3** State the CVP equation used to determine the sales level in dollars and the equation used to determine the sales level in units.
  - 4** Demonstrate by example how the CVP equations are used to determine breakeven sales in dollars and in units.
  - 5** Demonstrate by example how the CVP equations are used to determine sales volume in dollars and sales quantity in units.
  - 6** Explain the term contribution margin and the format of a contribution margin income statement.
  - 7** Discuss how operating income before tax and net income (after tax) can be used in the CVP equation.
  - 8** Discuss the use of CVP analysis to solve problems concerning joint fixed costs in a multiple-department organization.
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## THE CVP APPROACH TO DECISIONS

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Managers of hotels, motels, restaurants, and beverage operations, as well as other hospitality operations providing general goods and services, ask questions such as these:

- What will my operating income be at a specified level of sales revenue?
- What is the amount of additional sales revenue needed to cover the cost of expansion and still provide the wanted level of operating income?
- What effect will a change of selling prices have on my operating income?
- What effect will a change in the variable cost of sales have on my operating income?
- What increase in sales revenue is necessary to cover the cost of a wage increase and still provide the wanted levels of operating income?

These are but a few of many questions, which cannot be answered simply from a traditional income statement. They are, however, easily answered using

**CVP analysis.** To use the CVP method, costs must be separated into variable and fixed components. They are then used to make informed and rational decisions. However, before the CVP approach can be used, the assumptions and limitations inherent in the CVP method must be clearly understood.

## CVP ASSUMPTIONS AND LIMITATIONS

The following assumptions and limitations are built into CVP analysis:

- CVP analysis assumes all costs can be broken into variable and fixed elements with a reasonable level of accuracy.
- CVP assumes that identified fixed costs will remain unchanged during the period affected by the decision being made.
- CVP assumes that variable costs will increase or decrease in a consistent linear relationship with sales revenue during the period being evaluated.
- CVP is limited to specific situations, operating divisions, or departments. Great caution should be used concerning decisions for the entire organization when multiple divisions and departments contribute to overall income. In such cases, it may be appropriate to evaluate sales revenue mix (discussed in Chapter 6).
- CVP assumes that economic and other conditions will remain relatively stable during the period being evaluated. During a highly inflationary period, it might be difficult to forecast sales revenue, selling prices, and cost functions more than a month in advance. Certainly it would be risky to use CVP analysis for the next year.

Thus, CVP analysis produces only estimates to assist management in the decision process. CVP analysis relies on accounting information and mathematical computations, which may indicate a certain decision is appropriate. However, that decision does not consider customer and employee relations or social and potential environmental impact concerns.

## BREAKEVEN ANALYSIS

Before we begin our discussion of CVP analysis, we must become familiar with the basic analysis method upon which it is based. CVP analysis is a logical expansion of breakeven analysis. The objective of using the breakeven equation is to find the sales level in dollars or units necessary to cover all operating costs and produce operating income resulting in no profit or loss. However, begin with the following terms and the use of capital letters to designate their identity in each of the two basic breakeven equations, breakeven sales and breakeven units:

### The Breakeven Sales Equation

$$\frac{\text{Fixed costs}}{1 - (\text{Variable cost} / \text{Sales revenue})} = \frac{\text{Fixed costs}}{1 - \text{Variable cost} \%} = \frac{\text{Fixed costs}}{\text{Contribution margin} \%} = \underline{\underline{BESR}}$$

#### Abbreviations

Breakeven sales revenue =  $BESR$   
 Fixed costs =  $FC^*$   
 Sales revenue =  $SR$   
 Variable cost =  $VC$   
 Variable cost % =  $VC / SR$   
 100% of sales = 1  
 Contribution Margin % =  $1 - VC\%$

#### Breakeven Sales Equation

$$\begin{aligned} \text{Breakeven sales} &= \frac{FC}{1 - (VC / SR)} \\ &= \frac{FC}{1 - VC\%} \\ &= \frac{FC}{CM\%} = \underline{\underline{BESR}} \end{aligned}$$

\*Fixed costs is usually spelled out but more often is abbreviated FC in this chapter.

*Example A:* Fixed costs (FC) are \$128,000, sales revenue (SR) is \$240,000, and variable costs (VC) are \$187,200. What is breakeven sales revenue?

$$\begin{aligned} \frac{FC}{1 - VC / SR} &= \frac{FC}{1 - VC\%} = \frac{FC}{CM\%} = \underline{\underline{BESR}} \\ \frac{\$128,000}{1 - (\$187,200 / \$240,000)} &= \frac{\$128,000}{1 - 78\%} = \frac{\$128,000}{22\%} = \$581,818.18 \approx \underline{\underline{\$581,818}} \end{aligned}$$

### Breakeven Units Equation

$$\frac{FC}{SP[u] - VC[u]} = \frac{FC}{\text{Contribution margin}[u]} = \underline{\underline{BE[u]}}$$

#### Abbreviations

Breakeven sales units =  $BE[u]$   
 Selling price =  $SP[u]$   
 Variable cost per unit =  $VC[u]$   
 Variable cost % =  $VC[u] / SP[u]$   
 Sales price per unit =  $SP[u]$   
 Contribution margin =  $SP[u] - VC[u]$

#### Breakeven Units Equation

$$\begin{aligned} \text{Breakeven units} &= \frac{FC}{SP[u] - VC[u]} \\ &= \frac{FC}{CM[u]} = \underline{\underline{BE[u]}} \end{aligned}$$

*Example B:* Let us assume fixed costs ( $FC$ ) = \$128,000, variable costs ( $VC$ ) are \$187,200 on sales of \$240,000, and the average selling price of the units sold is \$20 each. Find breakeven sales in units.

$$\frac{FC}{SP[u] - VC[u]} = \frac{FC}{CM[u]} = \underline{\underline{BE[u]}}$$

$$\frac{\$128,000}{\$20.00 - \$15.60} = \frac{\$128,000}{\$4.40} = 29,090.90 \cong \underline{\underline{29,091 BE[u]}}$$

Four interesting relationships can be seen in these two equations. Referring to breakeven Examples A and B, we can observe that variable cost, sales revenue, and units of sales are tied together with respect to breakeven sales volume in dollars, and breakeven sales in units.

First, if we had known the average selling price per unit in Example A, where we found breakeven sales revenue, we could have also found breakeven units:

$$BESR / SP[u] = BE[u] = \$581,818.18 / \$20.00 = 29,090.90 \cong \underline{\underline{29,091 BE[u]}}$$

Note that any time breakeven sales in dollars and average selling price are being used to convert to sales in units, the entire decimal function (the decimal amount before rounding) must be used to complete the conversion. The same requirement exists when breakeven sales in units is being used to convert to breakeven sales revenue in dollars.

Second, the reverse is also true—having found breakeven units and knowing the selling price, we can find breakeven sales revenue ( $BE$  units must be used before rounding):

$$29,090.90 \times \$20.00 = \underline{\underline{\$581,818 BESR}}$$

Third, since the relationship between sales, unit selling price, variable cost percentage of sales, and the variable cost per unit are based on one set of data, we could have found the breakeven sales by using the base data shown in Example B.

$$\frac{FC}{1 - VC[u] / SP[u]} = \frac{\$128,000}{1 - (\$15.60 / \$20.00)} = \frac{\$128,000}{1 - 78\%} = \frac{\$128,000}{22\%} = \underline{\underline{\$581,818}}$$

Fourth, if you have the total variable costs, total sales revenue, and know the average unit-selling price, the variable cost per unit can also be found:

$VC = \$187,200$ ,  $SR = \$240,000$ , and average unit selling price is \$20.

$$\$187,200 / \$240,000 = 78\%, \text{ thus, } \$20 \times 78\% = \underline{\underline{\$15.60}} = VC[u]$$

It is important to note that final dollar answers are rounded to the dollar and final percentage answers are rounded to one tenth of a percent. Rounding of dollar or percentage answers cannot be made to the numerical figures or percentages when moving from sales units to sales revenues or sales revenues to sales units. To preclude any difficulty in rounding a decimal, use the same technique referred to in Chapter 3.

As you will soon see, these elements described in the calculation of break-even sales revenue or breakeven unit sales are used time and time again in completing a CVP analysis.

In this chapter, for the most part, we will use information developed in Chapter 7 concerning the Model Motel's room sales, fixed costs, and variable costs. Exhibit 8.1 provides the necessary information needed for a breakeven or CVP analysis.

In many cases, CVP analysis is presented in the form of a contribution margin income statement to check the validity of the CVP calculations. The contribution margin income statement is also used to answer questions concerning operating income when actual operating data does not agree with the forecasted sales level. The contribution margin income statement shown below uses the income statement information from Exhibit 8.1.

Sales revenue [15,300 units @ \$40 average room rate]		\$612,000
Variable cost of sales	\$226,000	
Fixed costs	<u>362,800</u>	
Total operating costs		( 588,800)
Operating income [before tax]		<u>\$ 23,200</u>
Other Information:		
a. 70 Rooms [units]		
b. Average room rate = <u>\$40.00</u>		
c. Occupancy rate: $\frac{15,300}{70 \times 365} = \frac{15,300}{25,550} = 59.9\% = \underline{60\%}$		
d. Average occupancy = $60\% \times 70$ rooms (units) = <u>42</u> units per night		
e. Variable cost per room occupied = $\frac{\$226,000}{15,300} = \underline{\$14.77}$		
f. Variable cost as a % of sales revenue: $\frac{\$226,000}{\$612,000} = \underline{36.9\%}$		

#### EXHIBIT 8.1

Information Required for a BE or CVP Analysis

***Contribution Margin Income Statement***

Sales revenue	\$612,000
Less: Variable cost	( 226,000)
Contribution margin	\$386,000
Less: Fixed costs	( 362,800)
Operating Income	<u>\$ 23,200</u>

Normally, details of variable and fixed costs, item by item, are shown directly on the income statement or supporting schedule. The contribution to fixed costs is typically referred to as the contribution margin. The contribution margin is sales revenue minus the cost of sales, which can also be expressed as a percentage of sales revenue. There may be other variable costs, which are not classified as cost of sales. Such variable costs will relate directly to expense items shown in the operating expense (wages expense, employee benefits, etc.) section of an income statement.

On the income statement for a large organization with a number of departments, sales revenue and cost of sales may be shown for each department, and/or a combined contribution margin for all departments may be shown. Total fixed costs of the organization are then deducted to arrive at operating income, which is income before tax. The contribution margin will be discussed later in this chapter.

Before we proceed further, let us look at a graphical presentation taken from the information shown in Exhibit 8.1, from the standpoint of breakeven analysis. The same procedures are followed if a graphical presentation is made for a CVP analysis.

## GRAPHICAL PRESENTATION

Generally, three steps are used to prepare of a graph for breakeven or CVP analysis. To prepare a graph, sales revenue and dollar costs are shown on the vertical axis and sales in units are shown on the horizontal axis, as shown in Exhibit 8.2.

*Step 1.* Using information from Exhibit 8.1, draw the fixed cost line by inserting a horizontal line from the vertical axis across the graph. The fixed cost line will originate on the vertical axis at a point representing \$362,800, as shown in Exhibit 8.2.

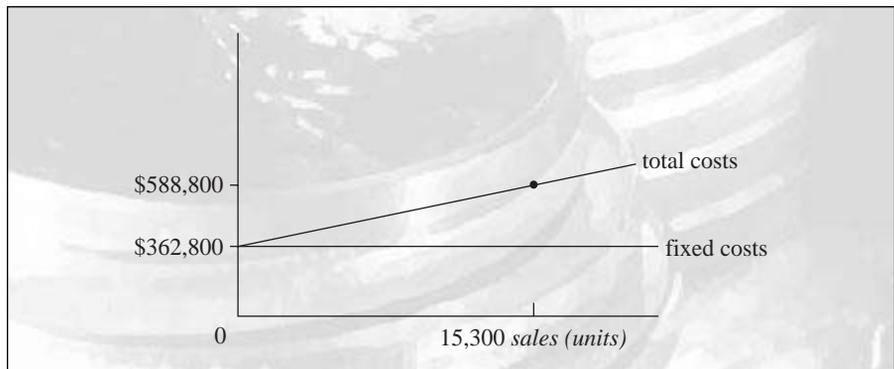
*Step 2.* Draw the total cost line. Mark \$588,800 on the vertical axis above the fixed cost line. Mark 15,300 units on the horizontal axis. Next, plot a point on the graph opposite \$588,800 and above 15,300. From the point on the vertical axis where fixed costs intersect, extend a line to intercept the point plotted opposite the total cost, as shown in Exhibit 8.3.

**EXHIBIT 8.2**

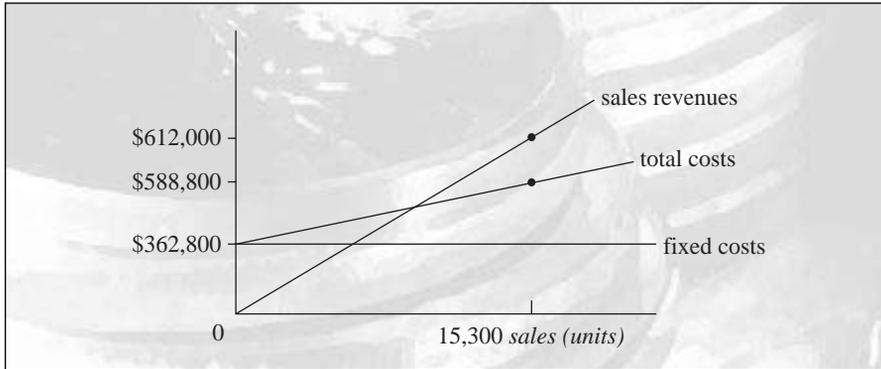
Fixed Cost Line

*Step 3.* Draw the sales revenue line. Mark a point on the vertical axis that represents \$612,000 sales revenue. Plot a point on the graph opposite \$612,000 and above the point that represents 15,300 sales units. Connect the intersection of the vertical and horizontal lines to the point you just plotted. The point where the total cost line intersects the sales revenue line is the breakeven point. Any sales level below the breakeven point shows a loss and any level above the breakeven point shows operating income (profit before tax).

Exhibit 8.4 shows a completed breakeven graph. (Exhibits 8.2, 8.3, and 8.4 are for illustration only; they were not drawn to scale.) Exhibit 8.5 shows a completed graph drawn to scale. This allows us to read certain information with better accuracy. The breakeven point is defined with greater accuracy at the point where the sales revenue line intersects with the total cost line; dotted horizontal and vertical lines aid in defining the intersection point. The dotted lines also

**EXHIBIT 8.3**

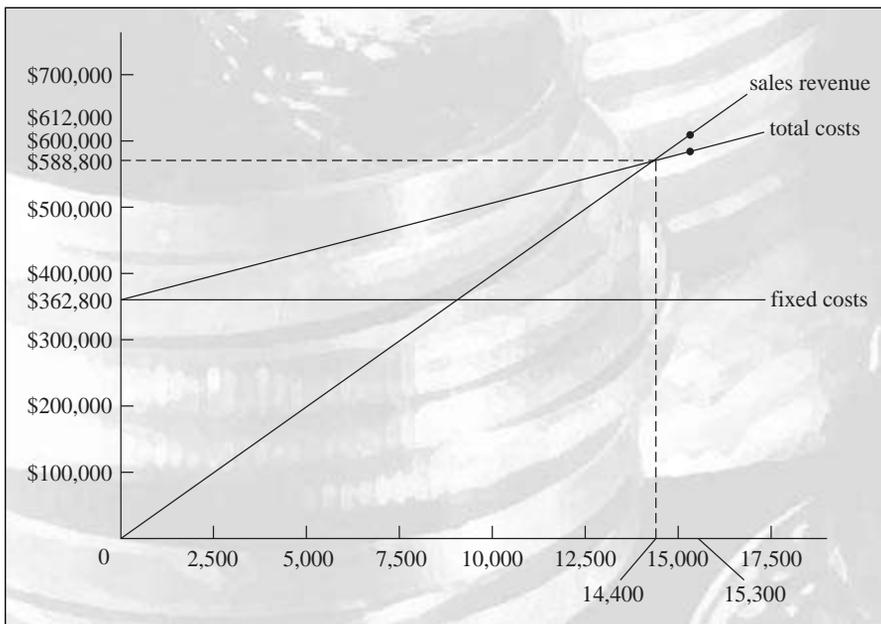
Total Cost Line

**EXHIBIT 8.4**

Sales Revenue and Costs

allow us to estimate the total sales revenue and sales units with reasonable accuracy. Using information from Exhibit 8.5, breakeven is approximately \$576,000 of sales revenue and 14,400 sales units.

Graphs may be accurate enough to give us an acceptable answer and lend themselves to being excellent tools to visually depict the information shown; however, structuring a graph can be time consuming. This is especially true if

**EXHIBIT 8.5**

Estimating Breakeven

a number of changes are needed to bring the graph up to date as a result of changing costs. Are graphs the best tool to estimate breakeven or required sales in dollars or units? If you are knowledgeable about breakeven and CVP equations, graphs can be used. Let us see how accurate the breakeven point is using a contribution margin income statement based on Exhibit 8.1.

Sales revenue at breakeven	\$576,000
Cost of sales [36.9% × \$576,000]	( 212,544)
Contribution margin	\$363,456
Less: Fixed costs	( 362,800)
Operating Income (before tax)	<u>\$ 656</u>

Using the contribution margin method, a \$656 operating income is shown. Using the breakeven equation, the breakeven would be:

$$\frac{\text{Fixed costs}}{1 - VC\%} = \frac{\$362,800}{1 - 36.9\%} = \frac{\$362,800}{63.1\%} = \underline{\underline{\$574,960}}$$

In the final analysis, the breakeven equation will provide the most accurate estimate of breakeven. If sales revenue falls below \$574,960, the Model Motel will begin losing money. Other questions that pertain to changing costs, sales revenue, or sales units can be answered more accurately and in less time by use of the breakeven equation.

Before moving to a discussion of CVP analysis, a comment is required regarding other fixed income an operation may be receiving, and how it should be treated during CVP analysis. We will assume the Model Motel has a coffee shop that is being leased out for \$10,000 per year. The \$10,000 received is other income and should not be included with regular sales revenue since it is a fixed inflow. The easiest and most acceptable solution is to deduct the lease income from fixed costs. If the motel wants to break even, the lease payment reduces the amount of money it must earn to pay for fixed costs. Therefore, fixed costs would be reduced from \$362,800 to \$352,800. The calculation after fixed costs are reduced by \$10,000 of other revenue, using the information from Exhibit 8.1:

$$\frac{\text{Fixed costs}}{1 - VC\%} = \frac{\$352,800}{1 - 36.9\%} = \frac{\$352,800}{63.1\%} = \underline{\underline{\$559,113 \text{ Breakeven}}}$$

The contribution margin income statement confirms the calculation.

Neither the variable cost percentage nor the contribution percentage changes but the calculation produces a different breakeven.

Sales revenue at breakeven	\$559,113
Cost of sales [36.9% × \$559,113]	( 206,313)
Contribution margin	\$352,800
Less: Fixed costs	( 362,800)
Operating Income (before tax)	<u>(\$ 10,000)</u>
Other Income	<u>\$ 10,000</u>
Income before tax	<u><u>-0-</u></u>

## CVP FORMULA

CVP analysis is a logical extension of breakeven analysis. Additional costs can be added to the numerator of the CVP equations in addition to the normal fixed cost. These additional costs are evaluated relative to the contribution margin to determine the sales revenue level necessary to cover the costs. As was the case with breakeven analysis, CVP uses two similar equations—CVP sales revenue and CVP sales units:

$$\text{Required sales (in dollars or units)} = \frac{\text{Fixed costs} + \text{Operating income}_{[BT]} + \text{New fixed costs}}{\text{Contribution margin percentage or units}}$$

It is necessary to identify the term to include potential added cost items.

- **Operating income (OI)** identifies operating income before tax. This identification is used on income statements and contribution margin income statements and in general discussion to indicate income before tax. **Profit before tax** is also substituted for operating income.

Operating income defines income before tax:

$$\begin{aligned} \text{Operating income}_{[BT]} &= \text{Sales revenue} - \text{Cost of sales} \\ &= \text{Gross margin} - \text{Operating expenses} \end{aligned}$$

$$\text{Operating income}_{[BT]} - \text{Tax} = \text{Net income}_{[AT]}$$

We will discuss changes that can be made to the elements of the CVP equation. These changes include changes to the variable cost percentages, fixed costs, unit variable costs, and unit selling prices. There can also be multiple changes of elements of the equation.

Using the information from Exhibit 8.1, we begin with CVP breakeven analysis by using the same figures we used earlier in the discussions of graphs.

$$\frac{\text{Fixed costs} + 0 \text{ net income}}{1 - VC\%} = \frac{\text{Fixed costs} + 0}{CM\%} = \text{BESR}$$

$$\frac{\$362,800 + 0}{1 - 36.9\%} = \frac{\$362,800}{63.1\%} = \underline{\underline{\$574,960 \text{ BESR}}}$$

We can use either a percentage or decimal figure in the denominator. It is important to remember that data being used to forecast breakeven and CVP are generally estimates, therefore, and breakeven is a best estimate.

### AT WHAT LEVEL OF SALES REVENUE WILL OPERATING INCOME BE \$39,000?

This CVP question is answered quickly using the CVP equation:

$$\begin{aligned} \text{Required sales revenue} &= \frac{\$362,800 + \$39,000}{1 - 36.9\%} \\ &= \frac{\$401,800}{63.1\%} \\ &= \underline{\underline{\$636,767}} \end{aligned}$$

### HOW MUCH MUST SALES REVENUE INCREASE TO COVER A NEW FIXED COST?

Normally, if fixed costs increase and no change is made in selling prices, profits can be expected to decline by the amount of the additional fixed cost. We can then ask the question: How much must sales revenue increase to compensate for a fixed cost increase and not decrease operating income? A simple answer is that sales revenue has to go up by the same amount as the fixed cost increases. But this is not correct, because to increase sales revenue (with no increase in selling prices) we have to sell more units; if we sell more units, our variable costs (such as wages and guest supplies) are going to increase. By trial and error, we could arrive at a solution, but our equation will solve this kind of question quickly:

$$\text{Required sales revenue} = \frac{\text{Old FC} + \text{New FC} + OI}{1 - VC\%}$$

Suppose we wish to increase our advertising by \$5,000 per year. What additional sales revenue level must be generated to provide \$5,000 of added cost and maintain the operating income at the present level of \$24,400? First, we can find the new required sales revenue and subtract the original sales revenue from it to determine the required increase in sales revenue.

$$\begin{aligned} \text{Required sales revenue} &= \frac{\$362,800 + \$5,000 + \$24,400}{1 - 36.9\%} \\ &= \frac{\$392,200}{63.1\%} \\ &= \underline{\underline{\$621,553}} \end{aligned}$$

We can verify the calculation by using a contribution margin income statement:

Sales revenue	\$621,553
Variable costs [ $\$621,553 \times 36.9\%$ ]	( 229,353)
Contribution margin	\$392,200
Less: Fixed costs ( $\$362,800 + \$5,000$ )	( 367,800)
Operating Income (before tax)	<u>\$ 24,400</u>

The solution tells us sales revenue to be \$621,553 to provide for the fixed cost, added cost, and operating income. The sales level increased by \$8,353 from the previous level of \$613,200. To find the number of additional rooms that must be sold, we use the average room rate of \$40 from Exhibit 8.1 and divide the increase by the average room rate:

$$\text{Increase in sales revenue} / \text{Average room rate} = \text{Additional rooms}$$

$$\underline{\$8,353} / \$40 = 208.8 \text{ or } \underline{\underline{209}} \text{ rooms per year}$$

Since we can't sell a part of a room, it is suggested we round a partial room up rather than down, from 208.8 to 209 rooms. If we divide the 209 additional rooms by 365 operating days, a little less than one additional room per day must be sold. If more than 209 rooms can be sold, not only will we pay for the advertising cost and the additional variable cost per room occupied, but we will also increase operating income.

In the problem just discussed, we worked the solution by evaluating additional sales revenue required, which was then converted to rooms to be sold. We could have answered this question working directly with room data. Let us see how this happens.

Variable cost per unit is \$14.77 (see Exhibit 8.1) and average sale per unit (average room rate) is \$40.

$$\text{Variable cost \%} = \frac{\$14.77}{\$40.00} = 0.3693 \times 100 = \underline{\underline{36.9\%}}$$

Included in the \$14.77 variable cost per unit is the cost of the wages of a housekeeper to clean the unit. Suppose the hourly wage rate for housekeepers (including all benefits) is \$8.00 an hour, and a housekeeper takes one-half hour to clean a room. Therefore, \$4.00 of the \$14.77 variable cost per room sold is for wages and benefits. Let us assume a 20 percent increase in housekeepers' wages:

$$\$4.00 + (20\% \times \$4.00) = \$4.00 + \$0.80 = \underline{\underline{\$4.80}}$$

or 
$$\$4.00 \times 1.20\% = \underline{\underline{\$4.80}}$$

Alternatively, we could say that our variable cost per unit is going to go up by \$0.80 and will now be

$$\$14.77 + \$0.80 = \underline{\underline{\$15.57}}$$

But if our variable cost per unit is now \$15.57 and there is no change in the average room rate, our variable cost percentage will no longer be the same as before. It will be:

$$\frac{\$15.57}{\$40.00} = 0.3893 \times 100 = \underline{\underline{38.9\%}}$$

We can now use this to answer the question: What must my new level of revenue be if my other fixed costs do not change, my profit must not drop, but housekeepers' wages are going to increase by 20 percent?

$$\begin{aligned} \text{Required sales revenue} &= \frac{FC + OI}{1 - VC\%} \\ &= \frac{\$362,800 + \$24,400}{1 - 38.9\%} \\ &= \frac{\$387,200}{61.1\%} \\ &= \underline{\underline{\$633,715}} \end{aligned}$$

Again, we'll use the contribution margin income statement to verify the answer:

Sales revenue	\$633,715
Variable costs [\$633,715 × 38.9%]	( 246,515)
Contribution margin	\$387,200
Less: Fixed costs	( 362,800)
Operating Income (before tax)	<u>\$ 24,400</u>

## WHAT ABOUT MULTIPLE CHANGES?

So far, only single changes have been considered. Multiple changes can be handled in the same way with no difficulties. For example, let us assume we are going to spend \$5,000 more on advertising, that our housekeepers are to get a 20 percent wage increase, and we now want our operating income to be \$40,000 rather than \$24,400. What must our revenue level be? Combining all these changes into one equation we have

$$\begin{aligned}
 \text{Required sales revenue} &= \frac{\text{FC} + \text{New FC} + \text{OI}}{1 - \text{VC}\%} \\
 &= \frac{\$362,800 + \$5,000 + \$40,000}{1 - 38.9\%} \\
 &= \frac{407,800}{61.1\%} \\
 &= \underline{\underline{\$667,430}}
 \end{aligned}$$

And the verification is this:

Sales revenue	\$667,430
Variable costs [\$667,430 × 38.9%]	( 259,630)
Contribution margin	\$407,800
Less: Fixed costs	( 367,800)
Operating Income [before tax]	<u>\$ 40,000</u>

## HOW CAN WE CONVERT THE SALES REVENUE LEVEL DIRECTLY INTO UNITS?

In the equation used so far, the denominator has been as follows:

$$100\% - \text{Variables costs as a \% of sales revenue}$$

The resulting net figure in the denominator is referred to as the contribution margin. In other words, if sales revenues is 100 percent and variable costs are 38.9 percent, then 61.1 percent of revenue is available as the contribution toward fixed costs and profit. The 61.1 percent figure is the contribution margin percentage.

The contribution margin can be expressed as a dollar amount, rather than as a percentage figure. For example, the Model Motel's average room rate (average sale per room) is \$40, and the variable costs (assuming an increase in housekeepers' wages) total \$15.57 per room; therefore, the contribution margin is \$24.43. In fact, our general equation for the sales level (either revenue or units) can be simplified like this:

$$\begin{aligned}\text{Required sales units} &= \frac{\text{Fixed costs} + \text{Operating income}}{\text{Contribution margin [u]}} \\ &= \frac{FC + OI}{SP[u] - VC[u]}\end{aligned}$$

The contribution margin is an important figure for any hospitality operation's manager to know because it shows how much of the sale of each item is available to cover fixed costs and provide a profit.

We have been using the CVP equation where the contribution margin in the denominator is expressed as a percentage. The required sales level we have calculated has been expressed in revenue dollars. If we use the equation above and express the contribution margin in dollars, we shall have a sales level expressed in units. Let us test this using information from the problem in the preceding section where we have increased advertising by \$5,000, wanted an increased operating income, and increased the housekeepers' wages.

$$\begin{aligned}\text{Required sales units} &= \frac{FC + OI}{SP[u] - VC[u]} = \frac{FC + OI}{CM[u]} \\ \text{Required sales units} &= \frac{\$362,800 + \$5,000 + \$40,000}{\$40.00 - \$15.57} \\ &= \frac{\$407,800}{\$24.43} \\ &= \underline{\underline{16,693 \text{ rooms}}}\end{aligned}$$

The reason we might want the solution in units is that in the case of a motel or hotel, it might be useful to have the required sales level converted to an occupancy percentage. This can be quickly calculated if we know the sales level in units.

From Exhibit 8.1 we know that our current occupancy level for the 70-room Model Motel is 60 percent. This was calculated by dividing units used by units available.

To cover our changed fixed and variable costs and the new operating income level, we have to sell 16,693 units a year, which is an occupancy of

$$\frac{16,693}{70 \times 365} = \frac{16,693}{25,550} = 0.6533 \times 100 = \underline{\underline{65.3\%}}$$

### IF ROOM RATES ARE CHANGED, WHAT WILL BE THE AFFECT ON ROOMS SOLD?

The contribution margin expressed in dollars is also used in answering questions concerning a change in selling prices. For example, assuming fixed costs are \$367,800 (\$362,800 + \$5,000), operating income required is \$40,000, and variable costs are \$15.57 per room used (increased housekeeping wages), what will our occupancy have to be to offset a 10 percent reduction in selling prices? Our new average rate will be \$36 instead of \$40.

$$\begin{aligned} \text{Required sales level (in units)} &= \frac{\$367,800 + \$40,000}{\$36.00 - \$15.57} \\ &= \frac{\$407,800}{\$20.43} \\ &= \underline{\underline{19,961 \text{ units}}} \end{aligned}$$

Occupancy will therefore have to be:

$$\frac{19,961}{70 \times 365} = \frac{19,961}{25,550} = 0.781 \times 100 = \underline{\underline{78.1\%}}$$

In other words, to compensate for a 10 percent (\$40 – \$4) cut in average room rate, our occupancy will have to jump from 65.3 percent to 78.1 percent. Expressed another way, we could say that we are going to have to sell nine more rooms per night on average (12.8% × 70 rooms available) to pay for a decrease in average room rate of 10 percent.

We could have arrived at the same result using the contribution margin expressed in percentages. In fact, it is sometimes necessary to do it this way when we have sales figures or results that cannot be converted to a unit basis. The equation in this case is a little lengthier:

$$\text{Required sales} = \frac{\text{FC} + \text{OI desired}}{100\% - \left( \frac{\text{Present variable cost \%}}{100\% \pm \text{Proposed percentage change in prices}} \right)}$$

We will use the same figures we have been using: Fixed cost is \$367,800, profit desired is \$40,000, variable costs are 38.9%, and a proposed rate decrease is 10 percent. Substituting in the equation, we have

$$\begin{aligned}
 \text{Required sales} &= \frac{\$367,800 + \$40,000}{100\% - \left(\frac{38.9\%}{100\% - 10\%}\right)} \\
 &= \frac{\$407,800}{100\% - \left(\frac{38.9\%}{90\%}\right)} \\
 &= \frac{\$407,800}{100\% - 43.2\%} \\
 &= \frac{\$407,800}{56.8\%} \\
 &= \underline{\underline{717,958}}
 \end{aligned}$$

In terms of number of units to be sold, this is

$$\frac{\$717,958}{\$36 \text{ (new rate)}} = \underline{\underline{19,943}}$$

This answer of 19,943 differs slightly from the answer obtained by using the earlier method (19,961), but the difference is caused solely by some slight rounding up to full units and rounding of percentages to the tenth of a percent in our calculations.

### HOW DOES THE EQUATION WORK IF WE HAVE A LOSS?

So far we have looked at the CVP equation in breakeven or profitable situations only. It can also be used to answer questions concerning a loss position. For example, using the original cost information suppose the Model Motel were in the following situation:

Sales revenue	<u>\$559,100</u> (\$559,100 / \$40 = 13,978 units)
Variable costs [36.9% × \$559,100]	\$206,308
Fixed costs	<u>362,800</u>
Total costs	<u>\$569,108</u>
Loss	<u>(\$ 10,008)</u>

The question is: What amount of additional sales must be achieved to eliminate the loss? The answer is to divide the amount of the loss by the contribution margin (using percentage figures for dollar answers, or using dollar figures if we want the answer in units).

$$\begin{array}{rcl}
 & \text{Dollar sales} & \text{Unit Sales} \\
 \text{Extra sales required} = & \frac{\$10,008}{100\% - 36.9\%} & \text{or } \frac{\$10,008}{\$40.00 - \$14.77} \\
 & = \frac{\$10,008}{63.1\%} & \text{or } \frac{\$10,008}{\$25.23} \\
 & = \underline{\underline{\$15,861}} & \text{or } \underline{\underline{397 \text{ units at } \$40}}
 \end{array}$$

If we wanted to calculate the additional volume required to eliminate the loss and give a profit of \$15,000, the numerator becomes the amount of the loss plus the profit desired.

$$\begin{array}{rcl}
 \text{Sales required} = & \frac{\$10,008 + \$15,000}{100\% - 36.9\%} & \text{or } \frac{\$10,008 + \$15,000}{\$40.00 - \$14.77} \\
 & = \frac{\$25,008}{63.1\%} & \text{or } \frac{\$25,008}{\$25.23} \\
 & = \underline{\underline{\$39,632}} & \text{or } \underline{\underline{991 \text{ units at } \$40}}
 \end{array}$$

Is the calculated answer correct? This can be confirmed by completing a contribution margin income statement:

<i>Contribution Margin Income Statement</i>	
Total sales revenue [\$559,100 + \$39,632]	\$598,732
Variable costs [36.9% × \$598,732]	( 220,932)
Contribution margin	\$377,800
Fixed costs	( 362,800)
Operating income (profit)	<u>\$ 15,000</u>

## WHAT ABOUT A NEW INVESTMENT?

The CVP equation has been used so far to illustrate how historical information from accounting records can be used to make decisions about the future. CVP analysis is equally valid when we have no past accounting information to help

us. In such a case, the fixed and variable costs have to be estimated in the best possible way. Suppose the Model Motel was considering renting the adjacent premises and converting the space into a 50-seat coffee shop to better serve the needs of its motel customers. The owner of the motel and the accountant have developed the cost projections shown in Exhibit 8.6. With this information we can answer the question: What must the minimum sales be to earn the return on investment desired? This can be answered by using the basic CVP equation.

$$\begin{aligned}
 \text{Required sales level} &= \frac{\text{Fixed expenses} + \text{Return on investment (profit)}}{100\% - \text{Variable cost \%}} \\
 &= \frac{\$85,600 + \$30,150}{100\% - 55\%} \\
 &= \frac{\$115,750}{45\%} \\
 &= \underline{\underline{\$257,222}}
 \end{aligned}$$

Assuming the estimates of costs are reasonably accurate, the owner of the Model Motel would have to decide whether the projected required sales revenue of \$257,222 could be attained from motel customers and other potential customers in the area. If the volume could be reached, then the new venture would be profitable.

Investment required for remodeling and for equipment and furniture, table settings, inventories, and other preopening items	<u>\$201,000</u>
Annual fixed costs are estimated to be:	
Rent	\$ 15,000
Depreciation of furniture and equipment	10,400
Basic labor cost for supervision, food preparation, and service	48,400
Insurance, telephone, utilities, advertising	<u>11,800</u>
Total	<u>\$ 85,600</u>
Variable operating costs will be kept to these levels relative to revenue	
Variable cost percentage, food	35%
Variable cost percentage, labor	15%
Variable cost percentage, other items	<u>5%</u>
Total variable operating costs as a percentage of sales revenue	<u>55%</u>
Return on investment required (15% on initial investment of \$201,000)	<u>\$ 30,150</u>

**EXHIBIT 8.6**

Investment and Cost Data for Proposed Coffee Shop

Once in business with the new restaurant, decisions about the coffee shop can then be made using CVP analysis in the same way as was demonstrated for the motel operation. Coffee shop sales revenue can also be handled on a unit basis. In this case, the unit is the customer and the average check is the measure of the amount of sale per unit, or customer. For example, at a sales level of \$257,222, and an average check of \$13.30 and the number of customers (units) is:

$$\frac{\$257,222}{\$13.30} = \underline{\underline{19,340}}$$

### WHAT ABOUT THE PROBLEM OF JOINT COSTS?

In the problems handled to date, the fixed costs have been identified with a single operation (a motel) or department (the restaurant), and this identification has been easy. What happens in the case of joint costs if, for example, a restaurant has a food department and beverage department? Some of the costs involved will be joint costs shared by the entire operation. In such a case, as long as the variable costs can be identified for each department, CVP analysis can still be useful. The fixed costs and the fixed portion of semifixed costs can still be handled in a joint manner.

Let us consider the large restaurant in Exhibit 8.7. Because each of the two departments has a different percentage of variable costs, and therefore a different percentage of contribution margin, a given revenue increase for one department will affect profit in a way different from the same given sales revenue increase in the other. Consider a \$15,000 sales increase in each of the two

	<i>Food Department</i>		<i>Beverage Department</i>	
Sales revenue (monthly)	\$150,000	100%	\$50,000	100%
Variable costs	( 75,000)	50%	( 20,000)	40%
Contribution margin	<u>\$ 75,000</u>	<u>50%</u>	<u>\$30,000</u>	<u>60%</u>
Total contribution margin		\$105,000		
Fixed costs		( 85,000)		
Operating Income		<u>\$ 20,000</u>		
Total contribution margin \$105,000 (\$75,000 + \$30,000)				

#### EXHIBIT 8.7

Operation with Joint Fixed Costs

departments in Exhibit 8.7. Assuming no change in fixed cost, the effect on profit will be as follows:

	<i>Food Department</i>	<i>Beverage Department</i>
Revenue increase	\$15,000	\$15,000
Variable costs	( 7,500) (50%)	( 6,000) (40%)
Increase in profit	<u>\$ 7,500</u>	<u>\$ 9,000</u>

If a revenue increase is desired, it is likely to come from both departments, not just one. Therefore, this is a problem of revenue mix. The problem does not, however, prevent us from using our CVP analysis.

Let us suppose the restaurant wanted a \$5,000 increase in operating income, with no change in the fixed costs or in the variable cost percentages. Under these circumstances, there are three ways to obtain the extra profit: an increase in food revenue only, an increase in beverage revenue only, and (what is more likely to happen in practice) a combined increase in food and beverage revenue.

#### Increase in Food Revenue Only

In the case of increasing food revenue only, the solution is arrived at with the basic CVP equation:

$$\begin{aligned}
 \text{Required food sales revenue} &= \frac{\text{Operating income increase}}{100\% - \text{Variable food \% to food revenue}} \\
 &= \frac{\text{Operating income increase}}{\text{Food contribution margin \%}} \\
 &= \frac{\$5,000}{50\%} \\
 &= \underline{\underline{\$10,000}}
 \end{aligned}$$

#### Increase in Beverage Revenue Only

The approach is exactly the same as for a food revenue increase only, except that we substitute the beverage contribution margin percentage for the food contribution margin percentage.

$$\begin{aligned}
 \text{Beverage revenue} &= \frac{\$5,000}{60\%} \\
 &= \underline{\underline{\$8,333}}
 \end{aligned}$$

### Combined Increase in Food and Beverage Revenue

Since food revenue increases have a different effect on profit than beverage revenue increases, to calculate how much we need in combined total revenue increase, we have to specify the anticipated ratio of food revenue to total revenue and the ratio of beverage revenue to total revenue. Let us suppose that any revenue increases will be in the ratio of 75 percent food and 25 percent beverage. Our equation for solving this type of revenue mix problem follows:

$$\begin{aligned}
 \text{Combined required sales revenue} &= \frac{\text{Operating income increase}}{(\text{Food revenue \%} \times \text{Food CM\%}) + (\text{Bev. revenue \%} \times \text{Bev. CM\%})} \\
 &= \frac{\$5,000}{(75\% \times 50\%) + (25\% \times 60\%)} \\
 &= \frac{\$5,000}{37.5\% + 15\%} \\
 &= \frac{\$5,000}{52.5\%} \\
 &= \underline{\underline{\$9,524}}
 \end{aligned}$$

It should be noted that the 52.5 percent contribution margin in this illustration is a weighted-average figure based on the sales revenue mix of food and beverage operations. We can easily check the accuracy of the answer obtained.

	<i>Food</i>	<i>Beverage</i>
Sales revenue	$75\% \times \$9,524 = \$7,143$	$25\% \times \$9,524 = \$2,381$
Variable costs	$50\% \times \$7,143 = (\underline{3,572})$	$40\% \times \$2,381 = (\underline{952})$
Contribution to operating income	<u>\$3,571</u>	<u>\$1,429</u>
Combined operating income	$\$3,571 + \$1,429 = \underline{\underline{\$5,000}}$	

### Compound Changes

Compound changes can be made with no difficulty. With reference to Exhibit 8.7, let us ask the following question: What would the total revenue level be if we wanted an operating income of \$25,000, if fixed costs increased to \$87,000, and if the revenue ratio changed to 70 percent for food and 30 percent

for beverage? There is no change in the contribution margin percentages. The solution:

$$\begin{aligned}
 \text{Total sales revenue} &= \frac{\$87,000 + \$25,000}{(70\% \times 50\%) + (30\% \times 60\%)} \\
 &= \frac{\$112,000}{(35\% + 18\%)} \\
 &= \frac{\$112,000}{53\%} \\
 &= \underline{\underline{\$211,321}}
 \end{aligned}$$

To confirm whether this is the correct answer, we can prepare a new condensed income statement for the restaurant, as in Exhibit 8.7.

	<i>Food Department</i>	<i>Beverage Department</i>
Sales revenue	70% × \$211,321 = \$147,925	30% × \$211,321 = \$63,396
Less: Variable costs	50% × \$147,925 = ( 73,963)	40% × \$ 63,396 = ( 25,358)
Contribution margin	<u>\$ 73,962</u>	<u>\$38,038</u>
Combined contribution margins	\$112,000	
Less: Fixed costs	( 87,000)	
Operating Income	<u>\$ 25,000</u>	

## INCOME TAXES

To this point in the discussion of CVP analysis, the effect of income taxes has been ignored. Obviously, at the breakeven level of sales there are no tax implications because there is no profit. Also, with a proprietorship or partnership the organization pays no income taxes. Any profits are deemed to be paid out to the owner(s), who then pay income tax on those profits at personal tax rates.

An incorporated company that has a taxable net income must, however, consider the tax implications when using CVP for decisions. Unfortunately, income tax is neither a fixed cost nor a variable cost dependent on sales. Taxes vary with operating income before tax and thus require special treatment in CVP analysis. This requires adjusting the CVP equation, substituting the term *operating income desired* which is *profit before tax*.

Consider the figures used earlier in this chapter, where the motel's net income desired was \$39,000 and the sales required to achieve this were calculated to be \$636,767. Assume now that the motel is in a 45 percent tax bracket. What

sales are required to achieve a \$39,000 after-tax profit? The \$39,000 can be converted to a before-tax figure as follows and as we learned in Chapter 6:

$$\text{Operating income increase} = \text{Net income}_{[AT]} / (1 - \text{Tax rate})$$

$$= \frac{\$39,000}{1 - 45\%}$$

$$= \frac{\$39,000}{55\%}$$

$$= \underline{\underline{\$70,909}}$$

$$\text{Tax} = \$70,909 - \$39,000 = \underline{\underline{\$31,909}} \quad \text{or} \quad \$70,909 \times 45\% = \underline{\underline{\$31,909}}$$

$$OI - NI_{[AT]} = \text{Tax} \quad \text{or} \quad \text{Operating income} \times \text{Tax rate} = \text{Tax}$$

Thus, if the motel with \$362,800 of fixed cost and variable costs of 36.9 percent of sales revenue and a net income after tax of \$39,000, the operating income would have to be \$70,909, and the tax equation would be used as shown in the preceding.

$$\text{Required sales revenue} = \frac{\text{Fixed cost} + (\text{Net income}_{[AT]} / 1 - \text{Tax rate})}{\text{Contribution margin \%}}$$

$$= \frac{\$362,800 + [\$39,000 / (1 - 45\%)]}{1 - 36.9\%}$$

$$= \frac{\$362,800 + \$70,909}{63.1\%}$$

$$= \frac{\$433,709}{63.1\%}$$

$$\text{Sales revenue} = \underline{\underline{\$687,336}}$$

The validity of calculating sales revenue, which covers all costs to include a specific amount of income after tax, can be verified as shown in a contribution margin income statement format:

Sales revenue	\$687,336
Variable costs [\$687,336 × 36.9%]	( 253,627)
Contribution margin	\$433,709
Fixed costs	( 362,800)
Operating income	70,909
Tax [\$70,909 × 45%]	( 31,909)
Net Income	<u>\$ 39,000</u>

## CONCLUDING COMMENTS

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We have seen only a few of the ways in which the CVP approach and the CVP equations can provide useful information for decision making. However, the mathematical answers arrived at are only as accurate as are the cost breakdowns used and the forecasts about changing costs and sales levels. The results of CVP analysis are not guaranteed because uncertainty about the future can never be eliminated. However, uncertainty is reduced using CVP analysis. Without it, decisions made might be nothing more than guesses. Finally, the reader is cautioned to refer again to the assumptions and limitations about CVP analysis listed at the beginning of this chapter.

## COMPUTER APPLICATIONS

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A spreadsheet program lends itself extremely well to performing the calculations for each of the equations or formulas discussed in this chapter. For example, the breakeven equation has to be entered only once into the program; for each given level of fixed and variable costs, the breakeven sales level can then be calculated, as can the total revenue required to achieve a desired profit. The results of one department can also be combined with those of others to indicate the effect on the overall net income of the operation. For example, if each additional occupied room generated an extra \$20 of food and beverage sales, this can be built into the spreadsheet program. Spreadsheet programs also have a graphics capability, which some managers often find more helpful than numbers alone.

## S U M M A R Y

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CVP analysis is a method of using knowledge about the level of fixed and variable costs in a business to help in making certain business decisions. The CVP approach must be used only with full knowledge about the assumptions and limitations inherent in it.

Information about sales, costs, and profits can be presented in a graphical form. Graphs are easy to prepare, and the information wanted can be read quickly. Graphs, however, are not very flexible when a variety of possible

changes are to be introduced. In such cases, an arithmetical approach using the CVP formula is much handier:

$$\text{Required sales revenue} = \frac{\text{Fixed costs} + \text{Operating income}}{1 - \text{Variable cost \%}}$$

If we wanted a sales level expressed in number of units (for example, number of rooms or number of customers) the equation is

$$\text{Required sales units} = \frac{\text{Fixed costs} + \text{Operating income}}{\text{Selling price [u]} - \text{Variable cost [u]}}$$

In both of these equations, the denominator is termed the *contribution margin*. Depending on whether the sales level is wanted in dollars or units, the CVP formula can be changed to include new fixed costs:

$$\text{Required sales (in dollars or units)} = \frac{\text{Fixed costs} + \text{Operating income [BT]} + \text{New fixed costs}}{\text{Contribution margin percentage or units}}$$

With the CVP equation, any of the variables (fixed costs, profit, variable costs) can be changed individually, or they can all be changed together, and the required sales level can be calculated. A special equation is required if unit selling prices are to be changed and variable costs are to be expressed as a percentage of revenue:

$$\text{Required sales revenue} = \frac{\text{Fixed costs} + \text{Operating income}}{100\% - \left( \frac{\text{Present variable cost \%}}{100\% \pm \text{Proposed percentage change in prices}} \right)}$$

The CVP formula can also be used where there are two or more departments (even if they have joint fixed costs) as long as the variable costs can be identified for each department, and a contribution margin percentage can be calculated for each department:

$$\text{Sales revenue} = \frac{\text{Fixed costs} + \text{Operating income}}{\left( \text{Dept. A \% of Total Revenue} \times \text{Dept. CM\%} \right) + \left( \text{Dept. B \% of Total Revenue} \times \text{Dept. CM\%} \right)}$$

Although the equation shown is for two departments, it can be extended for as many departments as an establishment may have.

Finally, the CVP analysis equation can be amended to take income tax rates

into consideration. The equation for converting an after-tax profit to a before-tax profit follows:

$$\text{Operating income} = \frac{\text{Net income}_{[AT]}}{1 - \text{Tax rate}}$$

$$\text{Operating income} - \text{Net income}_{[AT]} = \underline{\underline{\text{Tax}}}$$

To calculate the required sales for an operating income increase, the equation is

$$\frac{\text{Operating income increase}}{1 - \text{VC}\%} = \text{Required sales revenue}$$

## DISCUSSION QUESTIONS

1. Discuss two of the assumptions built into CVP analysis.
2. Discuss two of the limitations built into CVP analysis.
3. Give a brief explanation of how to prepare a breakeven graph or chart to be used in CVP analysis.
4. If one has used a breakeven graph to determine the breakeven level of revenue, how can one arithmetically test that the level selected is correct?
5. In an ongoing business, why is a graph not necessarily the best technique to use in CVP analysis?
6. What is the equation for calculating a particular revenue level in dollars using CVP analysis?
7. What is the equation for calculating required sales in units using CVP analysis?
8. Define the term contribution margin.
9. If management wants to know the sales level it would have to achieve to make a specific profit, how can the required sales level be calculated?
10. In studying the feasibility of a new operation, how can CVP analysis be used to determine the volume of sales required to give a desired return on investment?
11. A restaurant has a food department and a beverage department. Total revenue is made up of 80 percent food and 20 percent beverages. Food variable costs are 35 percent, beverage variable costs are 33 percent. What is the restaurant's combined contribution margin?
12. State the equation for converting an after-tax profit figure to a before-tax profit amount.

## ETHICS SITUATION

A restaurant manager has decided to change the restaurant's contribution margin percentages by lowering it for food and increasing it for beverages. In this way, he hopes to convince the restaurant's owner that a new investment in bar equipment will be rapidly paid for. Discuss the ethics of this situation.

## EXERCISES

- E8.1** A restaurant has sales revenue of \$240,000, fixed costs of \$100,800, and variable costs of \$96,000. What is breakeven sales revenue?
- E8.2** Fixed costs are \$145,000 and variable costs are 38 percent. What is breakeven sales revenue?
- E8.3** Fixed costs are \$240,000 and the contribution margin is 48 percent. What is breakeven sales revenue?
- E8.4** A restaurant has fixed costs of \$40,000 for the month of March 0002. The average check is \$12.50 with an average variable cost of \$7.50. What is breakeven units of sales for the month of March?
- E8.5** A small pub serving specialty beer only has fixed costs of \$50,400 per year. The average contribution margin on sales is \$2.24. What is the number of units to be sold to reach breakeven?
- E8.6** A restaurant has an average check of \$12.95, with an average variable cost of \$5.44. Fixed costs are \$140,000. Calculate the following:
- What is the unit contribution margin?
  - What are breakeven units?
  - What is the variable cost percentage?
  - What is the contribution as a percentage?
  - What is breakeven sales revenue?
- E8.7** The owner of a restaurant and bar operation wants a 20 percent net income after-tax return on his investment of \$180,000. The tax rate is 28 percent. What is the net income before tax and the income tax?
- E8.8** A hospitality operation has sales revenue of \$444,000 with variable cost averaging 42 percent. Fixed costs are \$188,482. The owner wants a net income after tax of \$48,000 based on a tax rate of 28 percent.
- Calculate the total additional sales revenue needed to support the desired net income after tax.
  - Calculate the total sales revenue required to cover fixed costs, tax, and net income after tax.

- E8.9** An operation operates with a variable cost percentage of 74 percent. The owner wants to increase sales by an amount necessary to provide for an additional operating income of \$500 a month, or \$6,000 a year. What is the additional increase in sales revenue required?
- E8.10** Assume the following information is provided:

$$\frac{\text{Fixed cost} + \text{Added cost} + \text{Increase for OI}_{[AT]}}{1 - \text{VC} / \text{SR}}$$

$$\frac{\$120,000 + \$12,000 + \$55,556}{1 - [\$151,200 / \$280,000]} = \frac{\$187,556}{1 - 54\%} = \frac{\$187,556}{46\%}$$

$$= \underline{\underline{\$407,730}}$$

Explain how each numerator item in the CVP equation is an individual item that can be calculated on its own to find the necessary sales revenue to cover that item. Calculate each element in the numerator individually item by item and total the individual calculations to confirm the \$407,730 for total sales revenue required is correct.

## PROBLEMS

- P8.1** A restaurant with an average check of \$10 per guest has the following average monthly figures:
- |                |           |
|----------------|-----------|
| Sales revenue  | \$500,000 |
| Variable costs | 260,000   |
| Fixed costs    | 160,000   |
- a. What is breakeven sales revenue?
  - b. If actual sales revenue was \$440,000, what would the restaurant's operating income be?
  - c. If actual sales revenue was \$440,000, how many fewer customers per month would be served than at the forecasted sales level of \$500,000 (average check remains at \$10)?
- P8.2** A small inn has annual fixed costs of \$86,000, variable costs of 70 percent of sales revenue, and a tax rate of 25 percent. The owner wants an after-tax net income of \$30,000. What sales revenue must be achieved to provide \$30,000 net income after tax? Prepare a contribution margin income statement to confirm the calculated required sales revenue.
- P8.3** A restaurant is being planned that will require an investment of \$150,000 in equipment by the owner. The following shows forecasted variable cost percentages, identifiable fixed, and semifixed costs.

*Variable costs will be:*

Food cost is 40% of sales revenue

Wage cost is 25% of sales revenue

Other variable costs are 10% of sales revenue

*Other known costs will be:*

Management salary and wages	\$48,000
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Insurance expense	2,800
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Advertising expense	4,500
---------------------	-------

Utilities and telephone expense	1,020
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Rent expense	12,000
--------------	--------

Equipment depreciation expense	20%
--------------------------------	-----

- a. What is the breakeven level of sales revenue for the restaurant? Prepare a contribution margin income statement to confirm the breakeven calculations.
  - b. What required sales revenue is needed if the owner wants a 15 percent before-tax return on investment? Prepare a contribution margin income statement to confirm the CVP calculations.
- P8.4** A cocktail bar is presently doing \$500,000 a year in sales. Liquor cost is 40 percent and other variable costs at this level of sales revenue total \$140,000. Fixed costs are \$120,000.
- a. What is the present annual operating income (before tax)?
  - b. The owner wants to increase the manager's salary by \$10,000 a year. By how much will sales revenue have to increase to provide this additional salary and maintain the current level of operating income? (Any added revenue will come from increasing seat turnover by increasing customer service.)
  - c. Rather than increasing sales revenue by increasing seat turnover and customer service, the owner decides to increase menu prices by 5 percent. The owner believes the price increase can be made without losing any customers and without increasing cost of sales or other variable costs. The original variable cost functions and the manager salary increase still apply. What will the bar's operating income (before tax) be?
  - d. With the new pricing structure as indicated in part c, how much can sales revenue decrease before operating income falls below \$30,000 per year?

**P8.5** A motel has 70 rooms it usually rents out, in the following proportions:

45% singles at:	\$48.00 per night
-----------------	-------------------

35% doubles at:	\$60.00 per night
-----------------	-------------------

20% triples at:	\$72.00 per night
-----------------	-------------------

The motel has annual fixed costs of \$345,000 and variable costs averages \$15.00 per room occupied.

- a. Calculate the motel's breakeven level and its occupancy percentage.
- b. Calculate the occupancy percentage that will provide operating income (before tax) of \$60,000 a year.
- c. Calculate the occupancy percentage necessary to provide an operating income (before tax) of \$60,000, if the average room rate were decreased by 15 percent.
- d. Calculate the occupancy percentage necessary to provide an operating income (before tax) of \$60,000, assuming the average room rate will increase by 10 percent. Variable cost per unit sold will increase to \$16.20, and \$30,000 per year will be spent on advertising.

**P8.6** A 90-room motel has an average room rate of \$65.60. Its fixed costs are \$300,000 a year, and its variable costs total \$476,000 at an average occupancy of 70 percent.

- a. What is the motel's breakeven occupancy percentage?
- b. What level of sales revenue is required to provide an operating income (before taxes) of \$100,000 a year?
- c. If the average room rate is increased by \$8.00, and operating income of \$100,000 a year is wanted, how many fewer rooms per night would need to be sold than was the case in part b?
- d. Wage rates for housekeepers are to be increased by \$4.00 an hour. It takes a housekeeper 1/2 hour to clean a room. Other cost increases will cause an increase of \$1.00 in the variable costs per room occupied. Fixed wages and other fixed costs are expected to increase \$4,000 per month. To compensate for the increase in room rate to \$73.60 (see part c), \$30,000 more per year is to be spent on advertising. Operating income (before tax) is to increase 20 percent over the present \$100,000 per year. What level of sales revenue is required? What is the sales revenue in terms of occupancy percentage?

**P8.7** The Relax Inn's rooms department has annual sales of \$600,000 and variable costs of \$180,000. The inn's food department has annual sales revenue of \$200,000 and variable costs of \$160,000. The inn's fixed costs are \$220,000. The total sales revenue of the inn is \$800,000 jointly.

- a. Calculate the inn's breakeven point, assuming the ratio of room's sales to food sales remains constant at any level of total sales.
- b. The owners want to increase their restaurant's sales revenue, and they plan to spend \$1,000 on brochures to be displayed in the inn's entry lobby and in the guest rooms. What level of incremental food sales must be achieved to cover the brochure cost? (Assume that room sales remain constant.)

- c. If the inn's owners want to increase operating income by \$40,000 by increasing rooms occupancy rate, what is the incremental room's sales revenue required to support the \$40,000 increase to operating income? (Assume no effect on restaurant sales.)
- P8.8** A restaurant has a café and bar operation. The café provides 65 percent of total revenue with a 48 percent variable cost. The bar provides 35 percent of total revenue with a 38 percent variable cost. Answer the following:
- What is the contribution margin of the café?
  - What is the contribution margin of the bar?
  - What is the combined contribution margin of the café and bar?
  - Assume the owner wants operating income to increase by \$50,000, with the increase being provided jointly by the café and bar. What is the additional sales revenue required?
- P8.9** A motel has a rooms department and a dining room, and fixed cost is \$335,000. Annual sales revenue and cost figures are as follows:

	<i>Rooms</i>	<i>Food</i>	<i>Totals</i>
Sales revenue	\$440,000	\$110,000	\$550,000
Variable costs	( 132,000)	( 66,000)	( 198,000)
Contribution margin	<u>\$308,000</u>	<u>\$ 44,000</u>	<u>\$352,000</u>

- What will be the increase in contribution margin if there is a \$20,000 increase in sales revenue only in the rooms department?
- What will be the increase in contribution margin if there is a \$20,000 increase in sales revenue only in the food department?
- If we want to double the current operating income before tax with variable costs remaining the same and covering fixed costs, what increase in room revenue is needed?
- If we want to double the current total operating income before tax with direct costs remaining the same and covering fixed costs, what increase in food sales revenue is needed?
- If we want to double the current operating income before tax with direct costs remaining the same, what will increase in sales revenue have to be if the increase is provided jointly by both departments combined? Assume sales revenue ratios stay as originally stated.
- What would total sales revenue have to be to achieve all of the following:
  - A doubling of present operating income before tax.
  - \$5,000 more spent on advertising.

- The revenue ratio to change from its present 80 percent for rooms and 20 percent for food to 75 percent for rooms, and 25 percent for food.
- Food variable costs to be decreased to 55 percent.

**P8.10** A neighborhood restaurant opens for lunch only and has a menu limited to five meals. The history of each menu item relative to its percentage of total sales, selling price (SP), and variable costs (VC) are shown in the following:

<i>Menu Item</i>	<i>SP</i>	<i>VC</i>	<i>SR%</i>
Food 1	\$15.00	\$7.75	16%
Food 2	12.95	7.50	20
Food 3	11.00	5.50	22
Food 4	8.95	2.85	14
Food 5	9.95	6.50	8

Total variable cost of beverages averages 55 percent. The restaurant has fixed costs of \$546,000 a year and wants an operating income (before tax) of at least \$25,000 per year.

- a. What level of revenue will give the desired operating income before tax?
  - b. Because of the low sales of menu item 5 and its relatively high variable cost percentage, management is considering removing this item from the menu. It is believed customers who formerly favored this item would then be split evenly over the remaining four menu items. Management also believes that improved cost control can reduce the beverage variable cost from 55 percent to 52 percent. Given these assumptions are valid, what level of revenue will be necessary to provide \$25,000 of operating income (before tax)?
  - c. Assuming that \$1,200,000 in sales revenue was achieved, what would be the restaurant's operating income before tax using the information in part b?
- P8.11** An owner has \$200,000 to invest in a new restaurant. Equipment and furniture are to be purchased for \$160,000, and \$40,000 will be used for initial working capital. First-year estimates anticipate variable costs as a percentage of sales revenue and food costs at 35 percent, variable wage costs at 30 percent, and other variable costs of 15 percent. Other fixed and semifixed costs estimates are as follows:

Management salaries	\$49,200
Rent expense	32,000
Insurance expense	4,800
Depreciation, furniture, and equipment	20%

The owner wants a 15 percent operating income (before tax) on his initial investment. As an alternative, the owner is considering borrowing \$60,000 from a bank at a 10 percent interest rate instead of using his own money for the investment. Rather than purchasing \$40,000 of the needed equipment, it would be rented at a cost of \$10,000 per year. Analyze each alternative, (1) using invested capital or (2) borrowing \$60,000, and renting some of the equipment. Calculate the annual sales revenue needed to provide operating income (before tax) of 15 percent of the initial investment. Recommend to the owner how to finance the operation.

- P8.12** A resort hotel has total annual sales revenue of \$1,000,000, variable costs of \$350,000, and fixed costs of \$570,000. The fixed costs include \$80,000 a year for land rental lease.
- Calculate the hotel's breakeven point.
  - If the owners had an equity investment in the hotel of \$1,200,000, what level of sales revenue is required for an operating income (before tax) representing a 12 percent return on their investment?
  - In a renegotiation of the land lease, the landowner has offered management an alternative to the current fixed lease currently being paid. The alternative is 10 percent of the resort's contribution margin.
    - If management accepts this proposal, what would be the resort hotel's new breakeven point?
    - Calculate the indifference point.
    - Explain whether management should accept this proposal if next year's total sales revenue is expected to be \$1,200,000?
    - Should management accept this proposal if next year's total sales revenue is expected to be \$1,400,000?

## C A S E 8

An analysis of the 4C Company's restaurant costs for the Year 2004 revealed the following:

- Food and beverage: Directly variable with total revenue.
- Salary and wages: \$156,400 fixed, the remainder are directly variable with total sales revenue.
- Laundry: Directly variable with total sales revenue.
- Kitchen fuel: \$3,800 fixed, the remainder are directly variable with total sales revenue.
- China and tableware: Directly variable with total sales revenue.
- Glassware: Directly variable with total sales revenue.

- Contract cleaning: Fixed.
  - Licenses: Fixed.
  - Other operating expenses: Directly variable with total sales revenue.
  - Administrative and general: Fixed.
  - Marketing: Fixed.
  - Utilities costs: \$3,100 fixed, the remainder directly variable with total sales revenue.
  - Insurance: Fixed.
  - Rent: Fixed.
  - Interest: Fixed
  - Depreciation: Fixed.
- a.** Refer to the income statements in Cases 2 and 3 and calculate the restaurant's total variable costs as a percentage of total sales revenue.
- b.** Calculate the restaurant's total fixed costs.
- c.** Calculate the restaurant's breakeven sales revenue and also express the breakeven in terms of the number of guests (using the average check from Case 3).
- d.** In Year 2004, the restaurant's operating income (before tax) is 6.9 percent of total sales revenue. To increase operating income to 10 percent, how many extra guests are required?