**Cost-Volume-Profit Relationships**

C**ost-volume-profit (CVP) analysis helps** managers make many important decisions such as what products and services to offer, what prices to charge, what marketing strategy to use, and what cost structure to maintain. Its primary purpose is to estimate how profits are affected by the following factors:

1. Sales volume.
2. Unit variable costs.
3. Total fixed costs.

To simplify CVP calculations, managers typically adopt the following assumptions with respect to these factors:

1. Selling price is constant. The price of a product or service will not change as volume changes.
2. Costs are linear and can be accurately divided into variable and fixed elements. **The variable element is constant per unit. The fixed element is constant in total over the entire relevant range.**

**Cost Volume Profit analysis** can answer questions such ask

1. What is our breakeven point? How many units do we have to sell to cover all of our fixed and variable costs and stay in business one more month?
2. If we want to achieve a certain profit, how many units do we have to sell?
3. If we increase our fixed expenses, how many more units do we have to sell to cover the costs?
4. If we increase our variable expenses, how will this affect our business?

**The Basics of Cost-Volume-Profit (CVP) Analysis**

CVP begins with the contribution income statement. The contribution income statement emphasizes the behavior of costs and therefore is extremely helpful to managers in judging the impact on profits of changes in selling price, cost, or volume.

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| --- |
| We will set up the problems for this chapter in the same way each time |
| using the contribution format |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
|  |  |  |  |  Total Dollars  |  | Per Unit |  | Ratios |
| Sales |  | S |  |  1,365  |  |  5.00  |  | 100% |
| -Variable Costs |  | -V |  |  820  |  |  3.00  |  | 60% |
| Contribution Margin |  | CM |  |  545  |  |  2.00  |  | 40% |
| -Fixed Costs |  | -F |  |  545  |  |  |  |  |
| Profit |  |  ¶ |  |  0 |  |  |  |  |

Notice that sales, variable expenses and contribution margin are expressed on a **per unit and ratio basis** as well as in total on this contribution income statement. Per unit and ratio figures will be very helpful to in some of our calculations. The contribution income statement is prepared for management’s use inside the company and would not ordinarily be made available to those outside the company.

Sales revenues, variable expenses, and contribution margin are expressed as a percentage or ratio of sales

Cost Behavior; Contribution Format Income Statement

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



Assume that the company produces and sells 45,000 units during the year at a selling price of $16 per unit. Prepare a contribution format income statement for the year.

**Contribution Margin**

**Contribution margin is the amount remaining from sales revenue after variable expenses have been deducted.** Thus, it is the amount available to cover fixed expenses and then to provide profits for the period. Notice the sequence here—contribution margin is used *first* to cover the fixed expenses, and then whatever remains goes toward profits. If the contribution margin is not sufficient to cover the fixed expenses, then a loss occurs for the period or the company breaks even.

Assume Joe sells one hamburger:



For each additional hamburger he sells during the month, $2 more in contribution margin becomes available to help cover the fixed expenses. If a second is sold, for example, then the total contribution margin will increase by $2 (to a total of $4) and the company’s loss will decrease by $2, to $541:



**Preparing a Contribution Format Income Statement**

Whirly Corporation’s most recent income statement is shown below:



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

1. The sales volume increases by 100 units.
2. The sales volume decreases by 100 units.
3. The sales volume is 9,000 units.

**Break-Even Analysis**

If Joe’s Hamburgers can sell enough to generate $545 in contribution margin, then all of the fixed expenses will be covered and he will *break even* for the month—that is, it will show neither profit nor loss but just cover all of its costs.

How can you calculate the break-even point in unit sold or dollars sales? Managers can use either of two approaches, the equation method or the formula method. We will only use the formula method.

**The Formula Method**

**Breakeven Quantities** In a single product situation, the formula to break even is BEQ = Fixed Expenses/CMU or Breakeven Quantities = Fixed expenses divided by contribution margin per unit

For Joe’s – Fixed expenses divided by contribution margin per unit ($545/$2) equals 273 hamburgers.

**Breakeven Sales**   We can also find the break-even point in dollar sales in two ways.

First, we could solve for the break-even point in *unit* sales or quantities using the formula method and then simply multiply the result by the selling price. Break-even point in dollar sales using this approach would be computed as 273 hamburgers × $5 or $1,365 in total sales.

Or, we can **use the formula method** to compute the dollar sales needed to break even as shown below:

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| Contribution Margin |  | CM |  |  545 |  |  2.00  |  | 40% |
| -Fixed Costs |  | -F |  |  545  |  |  |  |  |
| Profit |  |   |  |  0  |  |  |  |  |

The formula for breakeven sales is BES = Fixed Expenses/CMR which is Break even sales are equal to Fixed Expenses divided by the Contribution Margin Ratio. $545/.4 or approximately $1,365 in sales.

Summary:

BEQ = Fixed Expenses/CMU

BES = Fixed Expenses/CMR



**Break-Even**

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

***Required:***

Calculate the company’s break-even point in units (quantities) sales.

Calculate the company’s break-even point in dollar sales.

***Once the break-even point has been reached, net operating income will increase by the amount of the unit contribution margin for each additional unit sold.*** For example, if 274 hamburgers are sold in a month, then the net operating income for the month will be increased by $2 ($3 in total) because the company will have sold one hamburger more than the number needed to break even:



If 275 are sold (two above the break-even point), the net operating income for the month will be $5. If 276 are sold (three above the break-even point), the net operating income for the month will be $7, and so forth.

 **How to Quickly Calculate Profit once breakeven has been met**

**Units Sold**

To estimate the profit at any sales volume above the break-even point, multiply the **number of units sold in excess of the break-even point** by the unit contribution margin. The result represents the anticipated profits for the period. So, if our breakeven quantities for Joe’s are 273, if he sells 400 more (673 in total) the profit will be





**Dollar Sales Changes**

The CM ratio shows how the contribution margin will be affected by a change in total sales. A CM ratio of 40% means that for each **dollar increase** in sales, total contribution margin will increase by 40 cents ($1 sales × CM ratio of 40%). Net operating income will also increase by 40 cents, assuming that fixed costs are not affected by the increase in sales. Generally, the effect of a change in sales on the contribution margin is expressed in equation form as

**Dollar sales increase times contribution margin ratio**

As this illustration suggests, *the impact on net operating income of any given dollar change in total sales can be computed by applying the CM ratio to the dollar change.*

For example, if Joe plans a $3,000 increase in sales, the net operating income should increase to $1,200 ($3,000 increase in sales × CM ratio of 40%).

**Computing and Using the CM Ratio**

Last month when Holiday Creations, Inc., sold 50,000 units, total sales were $200,000, total variable expenses were $120,000, and fixed expenses were $65,000.

1. What is the company’s contribution margin (CM) ratio?
2. Estimate the change in the company’s net operating income if it were to increase its total sales by $1,000.

**Show the effects on net operating income of changes in variable costs, fixed costs, selling price, and volume using the contribution margin.**

Let’s demonstrate how the concepts developed on the preceding pages can be used in planning and decision making.



We will use this data to show the effects of changes in variable costs, fixed costs, sales price, and sales volume on the company’s profitability in a variety of situations.

**Change in Fixed Costs**

Joe is currently selling 873 hamburgers per month at $5 per hamburger for total monthly sales of $4,365. The restaurant manager feels that a $1,000 monthly advertising budget would increase monthly sales by $3,000 to a total of 1,473 hamburgers. Should Joe add advertising? The table below shows the financial impact of the proposed change in the monthly advertising budget.



Assuming no other factors need to be considered, the increase in the advertising budget should be approved because it would increase net operating income by $200.

Because in this case only the **fixed costs and the sales volume change**, the solution can also be quickly derived as:

Sales increase times CM ratio less additional fixed costs

$3,000 x 40% minus 1,000 (or $1,200 minus $1,000) equals $200

Sales were increased by $1,200 but it cost Joe $1,000 to obtain the additional sales. As a practical matter, advertising is expected to build momentum if the product is good. The sales increases should continue.

The solution involves incremental analysis—considering only the costs and revenues that will change if the new program is implemented. Although in each case a new income statement could have been prepared, the incremental approach is simpler and more direct and focuses attention on the specific changes that would occur as a result of the decision.

**Changes in Variable Costs, Fixed Costs, Selling Price, and Volume**

Data for Hermann Corporation are shown below:



Fixed expenses are $30,000 per month and the company is selling 2,000 units per month.

***Required:***

The marketing manager argues that a $5,000 increase in the monthly advertising budget would increase monthly sales by $9,000. Should the advertising budget be increased?

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**Change in Variable Costs and Sales Volume**

Joe’s is currently selling on average 873 hamburgers a month. It is considering using different brand of buns which would increase its variable expenses by 25¢ to $3.25 subsequently decreasing its contribution margin to $1.75 per hamburger. However, the restaurant manager predicts that using higher-quality bun would increase sales to 1,200 hamburgers per month. Should the higher-quality buns be used?



**Changes in Variable Costs, Fixed Costs, Selling Price, and Volume**

Data for Hermann Corporation are shown below:



Fixed expenses are $30,000 per month and the company is selling 2,000 units per month.

Management is considering using higher-quality components that would increase the variable expense by $2 per unit. The marketing manager believes that the higher-quality product would increase sales by 10% per month. Should the higher-quality components be used?

Hint: Calculate the 10% increase as an increase in the number of units sold

2,000 units times 110% equals 2,200 units

**Change in Fixed Cost, Selling Price, and Sales Volume**   Refer to the original data and recall again that Joe’s is currently selling 873 hamburgers per month. To increase sales, the restaurant manager would like to cut the selling price by 50¢ and place ads totaling $1,000 per month. The sales manager believes that if these two steps are taken, sales will increase by 50% to $1,310 hamburgers per month. Should the changes be made?

In this scenario, it is probably best to restate the contribution margin income statement and compare.



It would not be a good idea to make these changes.

**Change in Variable Cost, Fixed Cost, and Sales Volume**   Refer to original data. Instead of a family run operation where the family enjoys the profits, Joe now considers adding a work force of part time help during peak hours. This will increase fixed costs to $800 per month. The company will use a better grade of patty increasing the variable cost to by 75¢. These changes should increase volume to 2,500 burgers per month. Again, it is best to restate the contribution margin income statement to see the full implications of the changes.



**Special Order** The company has an opportunity to cater an event for 150 burgers. This sale would not disturb the company’s regular sales and would not affect total fixed expenses. What price per burger should be quoted to the wholesaler if Joe wants to make a profit of $200? (We will use the original data)

Variable cost per hamburger $3.00

Desired profit $200/150 burgers 1.33

Total price to charge $4.33



Notice that fixed expenses are not included in the computation. This is because fixed expenses are not affected by the catering sale, so the entire additional contribution margin increases the company’s profits.

**Determine the level of sales needed to achieve a desired target profit.**

*Target profit analysis* is one of the key uses of CVP analysis. In target profit analysis, we estimate what sales volume is needed to achieve a specific target profit. For example, suppose Joe wants to obtain a profit of $2,000 per month. To determine the unit sales and dollar sales needed to achieve a target profit, we can rely on the formula method.

**The Formula Method**

**Unit Sales or quantities** Generally, in a single product situation, we can compute the sales volume required to attain a specific target profit using the following formula:

**Target Profit Quantities**

T¶Q = (Target Profit + Fixed Expenses) divided by Contribution Margin per Unit

T¶Q = (T¶ + F)/ CMU

Target profit quantities = (2,000 + 545)/2 = 1,273



**Target Profit Analysis in Terms of Dollar Sales**   When quantifying the dollar sales needed to attain a target profit we can:

First, we can solve for the *unit* sales needed to attain the target profit using the formula method and then simply multiply the result by the selling price. In this case, the dollar sales to attain its target profit would be computed as 1,273 × $5 per speaker, or $6,365 in total sales.

Second, we can use the formula method to compute the dollar sales needed to attain the target profit as shown below:

**Target Profit Sales**

T¶s = (T¶ + F) divided by Contribution Margin Ratio

T¶s = (T¶ + F)/CMR

Target profit Sales = (2,000 + 545)/.4 = $6,365

**Summary**

T¶Q = (T¶ + F)/ CMU

T¶s = (T¶ + F)/CMR

**Target Profit Analysis**

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

***Required:***

1. Calculate the unit sales needed to attain a target profit of $10,000.
2. Calculate the dollar sales needed to attain a target profit of $15,000.

**Compute the margin of safety and explain its significance.**

The margin of safety is the excess of budgeted or actual sales dollars over the break-even volume of sales dollars. It is the amount by which sales can drop before losses are incurred. The higher the margin of safety, the lower the risk of not breaking even and incurring a loss. The formula for the margin of safety sales is:

Safety Margin Sales (SMS) = Actual sales minus Breakeven Sales (BES).

Therefore, to calculate safety margin sales, you have to solve for breakeven sales (BES = F/CMR)

The margin of safety can also be expressed in percentage form by dividing the Safety Margin Sales by total dollar sales:

Safety Margin Percentage = Safety Margin Sales (SMS)/Actual Sales

The calculation of the margin of safety for Joe’s Hamburgers is:

Current sales at 873 hamburgers $4,365

Breakeven Sales 1,365

Safety Margin of Sales $3,000

Safety Margin Percentage 68%

**Summary:**

Safety Margin Sales (SMS) = Actual sales minus Breakeven Sales (BES).

Therefore, to calculate safety margin sales, you have to solve for breakeven sales (BES = F/CMR)

Safety Margin Percentage = Safety Margin Sales (SMS)/Actual Sales

**Compute the Margin of Safety**

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



 **Required:**

1. What is the company’s margin of safety?

Safety Margin Sales (SMS) = Actual sales minus Breakeven Sales (BES).

Therefore, to calculate safety margin sales, you have to solve for breakeven sales (BES = F/CMR)

1. What is the company’s margin of safety as a percentage of its sales?

Safety Margin Percentage = Safety Margin Sales (SMS)/Actual Sales

**Structuring Sales Commissions**

Companies usually compensate salespeople by paying them a commission based on sales, a salary, or a combination of the two. Commissions based on sales dollars can lead to lower profits. To illustrate, consider Pipeline Unlimited, a producer of surfing equipment. Salespersons sell the company’s products to retail sporting goods stores throughout North America and the Pacific Basin. Data for two of the company’s surfboards, the XR7 and Turbo models, appear below:



Which model will salespeople push hardest if they are paid a commission of 10% of sales revenue? The answer is the Turbo because it has the higher selling price and hence the larger commission. On the other hand, from the standpoint of the company, profits will be greater if salespeople steer customers toward the XR7 model because it has the higher contribution margin.

To eliminate such conflicts, commissions can be based on contribution margin rather than on selling price. If this is done, the salespersons will want to sell the mix of products that maximizes contribution margin. Providing that fixed costs are not affected by the sales mix, maximizing the contribution margin will also maximize the company’s profit. In effect, by maximizing their own compensation, salespersons will also maximize the company’s profit.

**Sales Mix**

Compute the break-even point for a multiproduct company and explain the effects of shifts in the sales mix on contribution margin and the break-even point.

**The Definition of Sales Mix**

The term sales mix refers to the relative proportions in which a company’s products are sold. The idea is to achieve the combination, or mix, that will yield the greatest profits. Most companies have many products, and often these products are not equally profitable. Hence, profits will depend to some extent on the company’s sales mix. Profits will be greater if high-margin rather than low-margin items make up a relatively large proportion of total sales.

Changes in the sales mix can cause perplexing variations in a company’s profits. A shift in the sales mix from high-margin items to low-margin items can cause total profits to decrease even though total sales may increase. Conversely, a shift in the sales mix from low-margin items to high-margin items can cause the reverse effect—total profits may increase even though total sales decrease. It is one thing to achieve a particular sales volume; it is quite another to sell the most profitable mix of products.



**In Class Assignments**

**Using a Contribution Format Income Statement -** Miller Company’s most recent contribution format income statement is shown below:

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

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

Oslo Company prepared the following contribution format income statement based on a sales volume of 1,000 units (the relevant range of production is 500 units to 1,500 units):



1. What is the contribution margin per unit?
2. What is the contribution margin ratio?
3. What is the variable expense ratio?
4. If sales increase to 1,001 units, what would be the increase in net operating income?
5. If sales decline to 900 units, what would be the net operating income?

Oslo Company prepared the following contribution format income statement based on a sales volume of 1,000 units (the relevant range of production is 500 units to 1,500 units):



If the selling price increases by $2 per unit and the sales volume decreases by 100 units, what would be the net operating income?

Oslo Company prepared the following contribution format income statement based on a sales volume of 1,000 units (the relevant range of production is 500 units to 1,500 units):



If the variable cost per unit increases by $1, spending on advertising increases by $1,500, and unit sales increase by 250 units, what would be the net operating income?

Oslo Company prepared the following contribution format income statement based on a sales volume of 1,000 units (the relevant range of production is 500 units to 1,500 units):



What is the break-even point in unit sales?

What is the break-even point in dollar sales?

How many units must be sold to achieve a target profit of $5,000?

What is the margin of safety in dollars? What is the margin of safety percentage?