

Chapter 2

Introduction to Cost Behavior and Cost–Volume Relationships

LEARNING OBJECTIVES:

When your students have finished studying this chapter, they should be able to:

1. Explain how cost drivers affect cost behavior.
2. Show how changes in cost-driver levels affect variable and fixed costs.
3. Explain step- and mixed-cost behavior.
4. Create a cost-volume-profit (CVP) graph and understand the assumptions behind it.
5. Calculate break-even sales volume in total dollars and total units.
6. Calculate sales volume in total dollars and total units to reach a target profit.
7. Differentiate between contribution margin and gross margin.
8. Explain the effects of sales mix on profits (**APPENDIX 2A**).
9. Compute cost-volume-profit relationships on an after-tax basis (**APPENDIX 2B**).

CHAPTER 2: ASSIGNMENTS

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24. Mixed Costs and Sales Force
25. Marketing Function of Value-Chain and Cost Behavior
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31. Variable- and Fixed-Cost Behavior
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41. Cost-Volume-Profit at a Hospital
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48. Supper Value Grocery Chain, Variable and Fixed Costs
49. Fixed Costs and Relevant Range
50. Comparing Contribution Margin Percentages
51. Cost Structure and Risk Sharing
52. CVP for Promotion of a Rock Concert
53. Cost Drivers at Boeing
54. Basic CVP Relationships, Restaurant
55. Changing Fixed Costs to Variable Costs at Blockbuster Video
56. CVP and Financial Statements for a Mega-Brand Company

57. Bingo and Leverage
58. Operating Leverage at eBay
59. Adding a Product
60. Government Organization
61. Gross Margin and Contribution Margin
62. Choosing Equipment for Different Volumes
63. Sales Compensation, Variable/Fixed Costs, and Ethics
64. Sales-Mix Analysis
65. Hospital Patient Mix
66. Income Taxes on Hotels
67. Tax Effects, Multiple Choice

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68. Hospital Costs
69. CVP in a Modern Manufacturing Environment
70. Multiproduct Break-Even in a Restaurant
71. Effects of Changes in Costs, Including Tax Effects
72. Operating Leverage (Nike 10k Problem)

EXCEL APPLICATION EXERCISE

73. CVP and Break-Even

COLLABORATIVE LEARNING EXERCISE

74. CVP for a Small Business

INTERNET EXERCISE

75. Cost Behavior at Southwest Airlines
(<http://www.southwest.com>)

CHAPTER 2: OUTLINE

I. Identifying Resources, Activities, Costs, and Cost Drivers *{L. O. 1}*

Cost Drivers—Output measures of resources and activities. **EXHIBIT 2-1** shows the traditional and activity-based views of cost behavior. To apply the activity-based view, we must identify the resources used by each activity and the cost driver for each resource.

Organizations can have many cost drivers. In this chapter, volume-based cost drivers are used in order to examine cost behavior. See **EXHIBIT 2-2** for examples of costs and potential cost drivers for value-chain functions.

II. Variable and Fixed Costs *{L. O. 2}*

Variable and fixed costs refer to how cost behaves with respect to changes in a particular cost driver.

Variable Cost—a cost that changes in direct proportion to changes in the cost driver level (i.e., costs per unit do not change, total costs do change). Examples include the costs of materials, merchandise, parts, supplies, commissions, and many types of labor.

Fixed Cost—a cost that is not immediately affected by changes in the cost driver level (i.e., costs per unit do change, total costs do not change within the relevant range). Examples include real estate taxes, real estate insurance, many executive salaries, and space rentals. **EXHIBIT 2-3** summarizes the relationship between fixed and variable costs. See **EXHIBIT 2-4** for the relationship between the receiving activity and the costs of the fuel and equipment resources. See **EXHIBIT 2-5** for the total cost lines for total fuel and equipment lease costs.

A. Relevant Range

Relevant Range—the limits (i.e., time period and/or activity) of cost-driver activity within which a specific relationship between costs and the cost driver is valid. See **EXHIBIT 2-6** for a graph of fixed cost behavior within a relevant range.

III. Step and Mixed-Cost Behavior Patterns *{L. O. 3}*

A. Step Cost

Costs that change abruptly at different levels of activity because the resources are available only in indivisible chunks are step costs. If the chunks of cost apply to a relatively large range of activity, they are considered fixed costs within that range.

B. Mixed Costs

Many costs are mixed, which contain elements of both fixed- and variable-cost behavior. Fixed-cost is unchanged over the relevant range of activity levels whereas the variable-cost element of the mixed cost varies proportionately with cost-driver activity.

C. Effect of Time Horizon and Magnitude on Cost Behavior

Whether costs behave as fixed or variable often depends on the time frame affected by decision and on the magnitude of the change in cost-driver activity.

IV. Cost-Volume-Profit Analysis *{L. O. 4}*

Cost-Volume-Profit (CVP) Analysis—the study of the effects of output volume on revenue (sales), expenses (costs), and net income (net profit). The major simplifying assumption is to classify costs as either variable or fixed with respect to the volume of output activity. A CVP scenario follows.

A. Graphing the Break-Even Point

The BEP can also be found by graphing the cost and revenue relationships. The process takes the following steps.

Step 1: Draw the axes. The horizontal axis = sales volume, and the vertical axis = dollars of cost and revenue.

Step 2: Plot sales volume. Select a convenient sales volume and plot a point for total sales dollars at that volume. Then draw a line between the origin and the point.

Step 3: Plot the fixed expenses. It should be a horizontal line intersecting the vertical axis at the level of fixed costs.

Step 4: Plot variable expenses. Determine the variable expenses at a convenient level of activity. Add this amount to fixed expenses and plot the

point. Then draw a line from the intersection of the vertical axis to this point. This line represents total expenses, and the difference between the fixed expense line and this new line represents the variable expenses.

Step 5: Locate the break-even point. The break-even point is where the total expense line crosses the sales line.

See **EXHIBIT 2-8** for an illustration of a CVP graph. CVP graphs show profits over a wide volume range easier than numerical exhibits.

Almost all break-even graphs show revenue and cost lines extending back to the vertical axis. This approach misleads because the relationships depicted are only valid within the relevant range.

The assumptions used in constructing the typical break-even graph include the following:

1. Expenses may be classified into variable and fixed categories.
2. The behavior of revenues and expenses is accurately portrayed and is linear over the relevant range.
3. Efficiency and productivity will be unchanged.
4. **Sales Mix** (i.e., the relative proportions or combinations of quantities of products that constitute total sales) is constant. [See **APPENDIX 2A** for more on sales mixes.]
5. The difference in inventory level at the beginning and end of a period is insignificant.

B. Changes in Fixed Expenses

Increases (decreases) in fixed expenses increase (decrease) the BEP.

C. Changes in Unit Contribution Margin

Increases (decreases) in the CM per unit decrease (increase) the BEP.

V. Cost-Volume-Profit Analysis

A. Computing the Break-Even Point

{L. O. 5}

Break-Even Point (BEP) – the level of sales at which revenues equal expenses and net income is zero. One direct use of the BEP is to assess possible risk. By comparing planned sales with the BEP, managers can determine a **Margin of Safety**—how far sales can fall below the planned level before losses occur.

Margin of Safety = planned unit sales – break-even unit sales

1. **Contribution-Margin Method. Contribution Margin (CM) Per Unit**—the sales price per unit minus the variable expenses per unit. The BEP is reached when total contribution margin equals total fixed costs. Dividing total fixed costs by the CM per unit gives the BEP in number of units.
2. **CM Percentage or Ratio**—the portion of every sales dollar that contributes to covering fixed costs and, hopefully, provides for profit (divide total contribution margin by total sales). Dividing total fixed costs by the CM percentage (total contribution margin / total sales) yields the sales dollars needed to break even. The use of the CM percentage is necessary when a firm produces more than one product.

VI. Target Net Profit and an Incremental Approach *{L. O. 6}*

CVP analysis can be used to determine the target sales, in units and dollars, needed to earn a target profit. Using either the contribution margin or equation techniques results in the following shortcut equations.

$$\text{target sales volume in units} = \frac{\text{fixed expenses} + \text{target net income}}{\text{CM per unit}}$$

$$\text{target sales volume in dollars} = \frac{\text{fixed expenses} + \text{target net income}}{\text{CM ratio}}$$

- A. The **Incremental Approach** (i.e., the change in total results under a new condition in comparison with some given or known condition) can be used. Divide the target net income by the CM per unit and add the result to the unit BEP to get the target sales volume in units. Likewise, divide the target net income by the CM ratio and add the result to the dollar BEP to get the target sales volume in dollars.
- B. **Multiple Changes in Key Factors**

Multiple factor changes can be demonstrated by constructing income statements reflecting the changes and comparing before change and after change results. Also, an incremental approach is quicker and simpler. This keeps the analysis from being cluttered and irrelevant.

C. Nonprofit Application

Nonprofit organizations, such as government agencies, can use the principles of CVP analysis to determine how many individuals they can serve with limited budgets and to assess the impact of changes in the level of funding and/or costs on their ability to provide services. See **EXHIBIT 2-9** for a graphical presentation of the nonprofit analysis.

D. CVP Analysis and Computer-Based Spreadsheets

Numerous combinations of fixed expenses, selling prices, variable expenses, and target income levels can be analyzed quickly using these computerized spreadsheets. See **EXHIBIT 2-10** for an example of spreadsheet analysis.

VII. Additional Uses of Cost-Volume Analysis

A. Margin of Safety

The **margin of safety** shows how far sales can fall below the planned level of sales before losses occur. It compares the level of planned sales with the break-even point:

$$\text{margin of safety} = \text{planned unit sales} - \text{break-even unit sales}$$

A small margin of safety may indicate a more risky situation.

B. Operating Leverage

Operating Leverage—the firm's ratio of fixed and variable costs. In highly leveraged firms, (i.e., those with high fixed costs and low variable costs) small changes in sales volume will result in large changes in net income. Less leveraged firms show smaller changes in net income with changes in sales volume. However, below the BEP, losses mount more rapidly. See **EXHIBIT 2-11** for a graph comparing high versus low operating leverage.

C. Best Cost Structure

Companies try to find their most desirable combination of fixed- and variable-

cost factors. Some choose to increase their CM ratios and fixed costs by automating, whereas others may choose to lower their fixed costs and lower their CM ratios by putting their sales force on commissions rather than paying salaries.

When the CM percentage of sales is low, great increases in volume are necessary before significant improvements in net profits are possible. As sales exceed the BEP, a high CM percentage increases profits faster than a low CM percentage.

VIII. Contribution Margin and Gross Margin *{L. O. 7}*

Gross Margin (or Gross Profit)—the excess of sales over the **Cost of Goods Sold** (i.e., cost of the acquired or manufactured merchandise to be sold). **Contribution Margin** is the excess of sales over all variable expenses. See **EXHIBIT 2-12** which shows costs divided on two different dimensions: gross margin and contribution margin.

IX. Appendix 2A: Sales-Mix Analysis *{L. O. 8}*

Sales Mix—the relative proportions or combinations of quantities of products that comprise total sales. If the proportions of the mix change, the CVP relationships may also change. Generally, selling a higher (lower) proportion of high CM products than anticipated results in higher (lower) net income. Factors other than CM per unit of product (e.g., CM per unit of time) can be useful in making sales mix decisions (see **Chapter 5** for further explanation).

X. Appendix 2B: Impact of Income Taxes *{L. O. 9}*

The target sales equation can be altered to the following:

$$\text{target sales} - \text{variable expenses} - \text{fixed expenses} =$$

$$\text{target after-tax income} / (1 - \text{tax rate})$$

Letting N = the number of units of sales necessary to achieve the desired after-tax income and substituting values for the selling price per unit, variable expenses per unit, fixed expenses, target after-tax income, and the tax rate into the equation, N can be solved. Alternatively, the following shortcut formula may be used:

$$\text{change in net income} =$$

$$(\text{change in volume in units}) \times (\text{CM per unit}) \times (1 - \text{tax rate})$$

Each unit beyond the **BEP** adds to after-tax net profit at the unit **CM** multiplied by $(1 - \text{income tax rate})$.

When incorporating income taxes in **CVP** analysis, the **BEP** does not change because the **BEP** is the point of zero profits. Therefore, there are no taxes on zero profits.

CHAPTER 2: Quiz/Demonstration Exercises

Learning Objective 1

1. Cost drivers _____.
 - a. can be volume based
 - b. affect the total level of costs incurred by companies
 - c. all of these
 - d. are activities that cause costs to be incurred

2. Production is one of the value-chain functions. Which one of the following is not an example of a cost driver for production costs?
 - a. number of people supervised
 - b. labor hours
 - c. machine hours
 - d. sales dollars

Learning Objective 2

3. Which of the following will not remain constant, if the level of cost-driver activity increases within the relevant range?
 - a. variable cost per unit
 - b. total variable costs
 - c. total fixed costs
 - d. A and C
 - e. total costs
 - f. B, C, and E

4. The limits of cost-driver activity within which a specific relationship between costs and the cost driver is valid is called _____.
 - a. relevant range
 - b. variable range
 - c. total range
 - d. valid range

Learning Objective 3

5. A cost that changes abruptly at interval of activity because the resources and the costs in indivisible chunks is called a(n) _____ cost.

- a. indivisible
 - b. mixed
 - c. activity
 - d. step
6. The _____ portion of mixed cost that remains constant per unit with activity within the relevant range.
- a. indivisible
 - b. fixed
 - c. variable
 - d. step

Learning Objective 5

Items 5 and 6 are based on the following data:

Diablo, Inc., produces and sells the finest quality pool tables in all of Contra Costa County, California. The company expects the following sales and expenses in 2011 for its tables:

Sales (1,000 tables @ \$400 per table)	\$ 400,000
Variable expenses	200,000
Fixed expenses	120,000

7. How many tables must be sold in order for Diablo, Inc., to break even?
- a. 800
 - b. 600
 - c. 400
 - d. 200
8. What dollar amount of sales of tables is necessary to break even?
- a. \$120,000
 - b. \$ 60,000
 - c. \$240,000
 - d. \$150,000

Learning Objective 4

9. Which of the following is **not an assumption** of cost-volume-profit analysis?
- The behavior of revenues and expenses is accurately portrayed and is linear over the relevant range.
 - Efficiency and productivity will both increase.
 - Sales mix will be constant.
 - Expenses can be classified into variable and fixed categories.
 - The inventory level at the end of the period will be insignificantly different from that at the beginning.
10. Increase in contribution margin per unit _____.
- decreases break-even point
 - increases break-even point
 - does not change break-even point
 - means there is a change in fixed cost per unit

Learning Objective 6

Items 11 and 12 are based on the following data (ignore income taxes):

Moto, Inc., manufactures and sells scooters. A projected income statement for the expected sales volume of 100,000 scooters is as follows:

Sales	\$7,500,000
Variable expenses	<u>3,000,000</u>
Contribution margin	\$4,500,000
Fixed expenses	<u>2,500,000</u>
Before-tax profit	<u>\$2,000,000</u>

11. How many scooters would need to be sold to have a before-tax profit of \$2,900,000?
- 130,000
 - 110,000
 - 120,000
 - 100,000
 - 140,000
 - none of the above
12. What dollar sales volume would be required to achieve \$3,500,000 of before-tax profit?
- \$7,000,000

- b. \$10,000,000
- c. \$9,500,000
- d. \$7,500,000
- e. some other amount

Learning Objective 7

13. The difference between sales and cost of goods sold is commonly called _____.
- a. gross profit
 - b. operating income
 - c. contribution margin
 - d. net income
14. If variable selling expenses increase, then contribution margin (assuming all else constant) must _____.
- a. increase
 - b. need more information
 - c. stayed the same
 - d. decrease

Learning Objective 8

15. Dual Co produces and sells two products. Product A sells for \$8 and has variable expenses of \$3. Product B sells for \$18 and has variable expenses of \$10. It predicts sales of 20,000 units of A and 10,000 units of B. Fixed expenses are \$100,000 per month. Assume that Dual Co. hits its sales goal for February of \$600,000, and exceeds its expected before-tax profit of \$70,000. What has happened?
- a. TwinCo sold 40,000 units of product A and no product B.
 - b. TwinCo sold more of both products A and B than expected.
 - c. TwinCo sold more of product B and less of product A than expected.
 - d. TwinCo sold more of product A and less of product B than expected.
16. Breakeven in units for a multi-product firm is calculated as fixed costs divided by _____.
- a. the sum of the contribution margin percentages for each product
 - b. the sum of the individual product contribution margins
 - c. the weighted average contribution margin of all the products
 - d. it is not possible to calculate breakeven in units for a multi-product firm

Learning Objective 9

17. Refer to the data provided for Moto, Inc., in problems 11 and 12. Now assume that Moto, Inc., is subject to a 40% tax. How many scooters must it sell to achieve an after-tax income of \$1,500,000?
- a. 66,666
 - b. 333,333
 - c. 111,111
 - d. 142,857
18. After-tax profit equals before-tax profit _____.
- a. multiplied by the tax rate
 - b. divided by 1 minus the tax rate
 - c. divided by the tax rate
 - d. multiplied by 1 minus the tax rate

CHAPTER 2: Solutions to Quiz/Demonstration Exercises

1. *[c]*
2. *[d]*
3. *[d]*
4. *[a]*
5. *[d]*
6. *[c]*

7. *[b]* The CM per unit must be computed. In this case, it is \$200 ($\$400,000 - \$200,000$)/1000 tables. Dividing the \$120,000 fixed expenses by the \$200 per unit CM gives 600 tables.

8. *[c]* Either multiplying the unit BEP by the unit selling price or by dividing the fixed expenses by the CM ratio. Using the first method, 600 tables multiplied by a price of \$400 per table gives \$240,000 of sales to break even. With the second method, \$120,000 of fixed expenses divided by .50 ($\$200,000 \text{ CM}/\$400,000 \text{ Sales}$) also yields \$240,000 to break even.

9. *[b]*
10. *[a]*

11. *[c]* Add the before-tax desired profit to the fixed expenses and divide the result by the CM per unit. In this case, $\$2,900,000 + \$2,500,000 = \$5,400,000 / (\$4,500,000 / 100,000 \text{ cases})$ gives 120,000 cases.

12. *[b]* Divide the sum of the target before-tax income and the fixed expenses by the CM percentage. In this case that is $\$6,000,000 [\$3,500,000 + \$2,500,000]$ divided by .60 [$\$4,500,000/\$7,500,000$] = \$10,000,000.

13. *[a]*
14. *[d]*

15. *[d]* The CM ratios for the two products are 62.5% for A and 44.4% for B. When the sales mix shifts to products with higher CM ratios, profits increase.

16. *[c]*

17. *[c]* To solve this problem it is necessary to convert the after-tax income desired to the before-tax income necessary. Dividing \$1,500,000 by .60 (1 - tax rate) gives

\$2,500,000 in before-tax income required. Adding this to the \$2,500,000 in fixed expenses yields a required contribution margin of \$5,000,000. Using the data provided for 100,000 scooters, the selling price per scooter is \$75.00 and the variable expenses per scooter are \$30.00. This gives a CM per unit of \$45.00, which can be divided into the \$5,000,000 total contribution margin to give 111,111 scooter needed to sell to get \$1,500,000 after-tax profit.

18. *[d]*