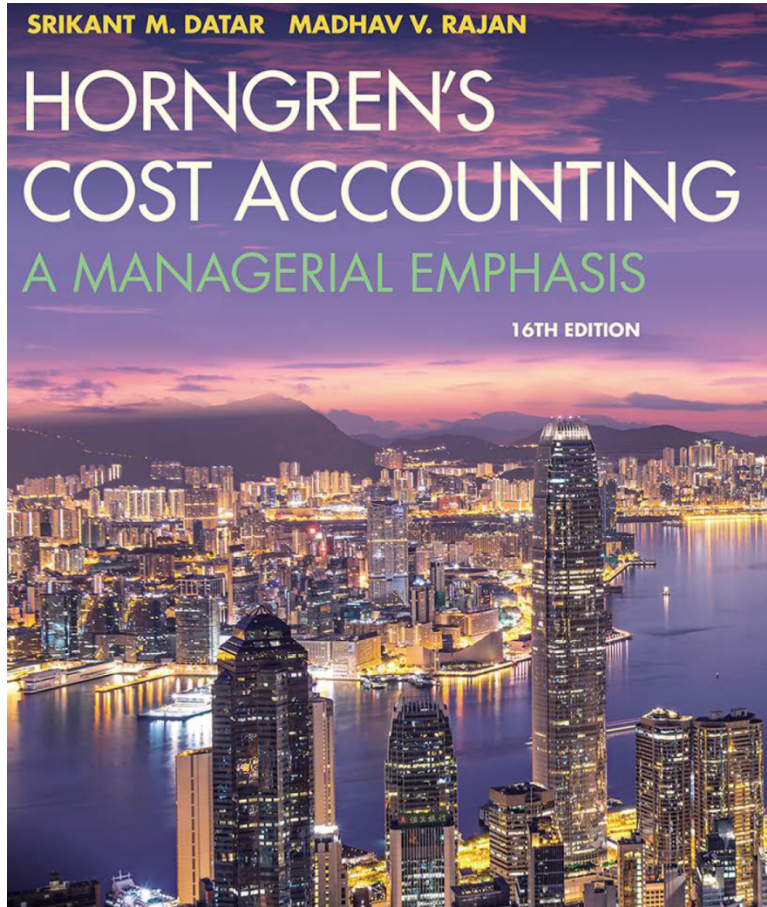


Cost Accounting

Sixteenth Edition



Chapter 3

Cost-Volume-Profit Analysis

Essentials of CVP Analysis

- **Managers want to know how profits will change as the units sold of a product or service changes.**
- **Managers like to use “what-if” analysis to examine the possible outcomes of different decisions so they can make the best one.**
- **In chapter 2, we discussed total revenues, total costs and income.**
- **In this chapter, we take a closer look at the relationship among the elements (selling price, variable costs, fixed costs)**

A Five-step Decision-Making Process in Planning and Control-Revisited

- 1. Identify the problem/uncertainties**
- 2. Obtain information**
- 3. Make predictions about the future**
- 4. Make decisions by choosing between alternatives using cost-volume-profit (CVP) analysis**
- 5. Implement the decision, evaluate performance and learn.**

Foundational Assumptions Used in CVP Analysis (1 of 2)

- Changes in production/sales volume are the sole cause for cost and revenue changes.
- Total costs consist of fixed costs and variable costs.
- Revenue and costs behave and can be graphed as a linear function (a straight line).
- Selling price, variable cost per unit and fixed costs are all known and constant.

Foundational Assumptions Used in CVP Analysis (2 of 2)

- 5. In many cases, only a single product will be analyzed. If multiple products are studied, their relative sales proportions are known and constant.**
- 6. The time value of money (interest) is ignored.**

Basic CVP Equations

Contribution Margin =

Total Revenue - Total Variable Costs

Contribution Margin per unit =

Selling price - Number of units sold

Operating Income =

Contribution margin - Fixed costs

Contribution Margin Ratio (or Percentage) =

Contribution Margin / Revenue

More CVP Relationships

Manipulation of the basic equations (prior slide) yields an extremely important and powerful tool called Contribution Margin.

Contribution margin equals revenue less variable costs.

Contribution margin per unit equals unit selling price less unit variable costs, but can also be determined by taking contribution margin divided by number of units sold

Cost-Volume-Profit Equation and Contribution Margin Methods

EQUATION METHOD: REVENUE - VARIABLE COSTS - FIXED COSTS = OPERATING INCOME

CM METHOD: WHERE: $[(SP \times Q) - (VC \times Q)] - FC = OI$

REVENUE = SELLING PRICE (SP) * QUANTITY OF UNITS SOLD (Q)

VARIABLE COSTS (VC) = UNIT VARIABLE COSTS * QUANTITY OF UNITS SOLD

CONTRIBUTION MARGIN (CM) = REVENUE - VARIABLE COSTS

OPERATING INCOME (OI) = CONTRIBUTION MARGIN - FIXED COSTS

Cost-Volume-Profit – You Try It!

Problem

$$\text{REVENUE} - \text{VARIABLE COSTS} - \text{FIXED COSTS} = \text{OPERATING INCOME}$$

Tiny's Cabinets sells cabinets for \$600 each

Variable cost is \$350 each

Annual fixed costs are \$20,000

If Tiny sells 100 cabinets, what is his operating income?

Cost-Volume-Profit – You Try It!

Solution

Tiny's Cabinets sells cabinets for \$600 each

Variable cost is \$350 each

Annual fixed costs are \$20,000

If Tiny sells 100 cabinets, what is his operating income?

Solution: $[(SP \times Q) - (VC \times Q)] - FC = OI$

$(\$600 \times 100) - (\$350 \times 100) = \text{Contribution Margin}$

$CM - \$20,000 = \text{Operating Income}$

$\$60,000 - \$35,000 - \$20,000 = \$5,000$

Breakeven Point

The breakeven point (BEP) is that quantity of output sold at which total revenue equals total cost - that is, the quantity of output sold results in \$0.00 of operating income.

Recall our contribution margin method equation:

$$[(SP \times Q) - VC \times Q] - FC = OI$$

If we set OI to 0 and solve, we'll get the BEP.

Breakeven Point-Example (1 of 2)

Let's try this for Tiny's Cabinets. Recall that his **SP = \$600**, **VC = \$350** and **Fixed Costs are \$20,000**, annually.

$$[(SP \times Q) - (VC \times Q)] - FC = OI$$

$$(\$600 \times Q) - (\$350 \times Q) - \$20,000 = 0$$

$$\$250 \times Q = 20,000$$

$$Q = 80$$

Here's another way to find the answer:

$$\text{Breakeven revenues} = FC / CM\%$$

$$\text{Breakeven units} = FC / CM \text{ per unit}$$

Breakeven Point-Example (2 of 2)

Let's try this for Tiny's Cabinets. Recall that his SP = \$600, VC = \$350 and Fixed Costs are \$20,000

Here's another way to find the answer:

Breakeven revenues = FC / CM per unit

Tiny's CM per unit = \$600 - \$350 = \$250

Tiny's CM % = \$250/\$600 = 41.67%

\$20,000 / \$250 = 80

Or, in revenues \$20,000/41.67% = \$47,996 which is equal to 80 x \$600, allowing for rounding

Breakeven Point-Extended: Profit Planning/Target Income

The breakeven formula can be modified to become a profit planning tool by adding target operating income to fixed costs in the numerator.

Let's say that Tiny wants to make \$30,000 Operating Income:

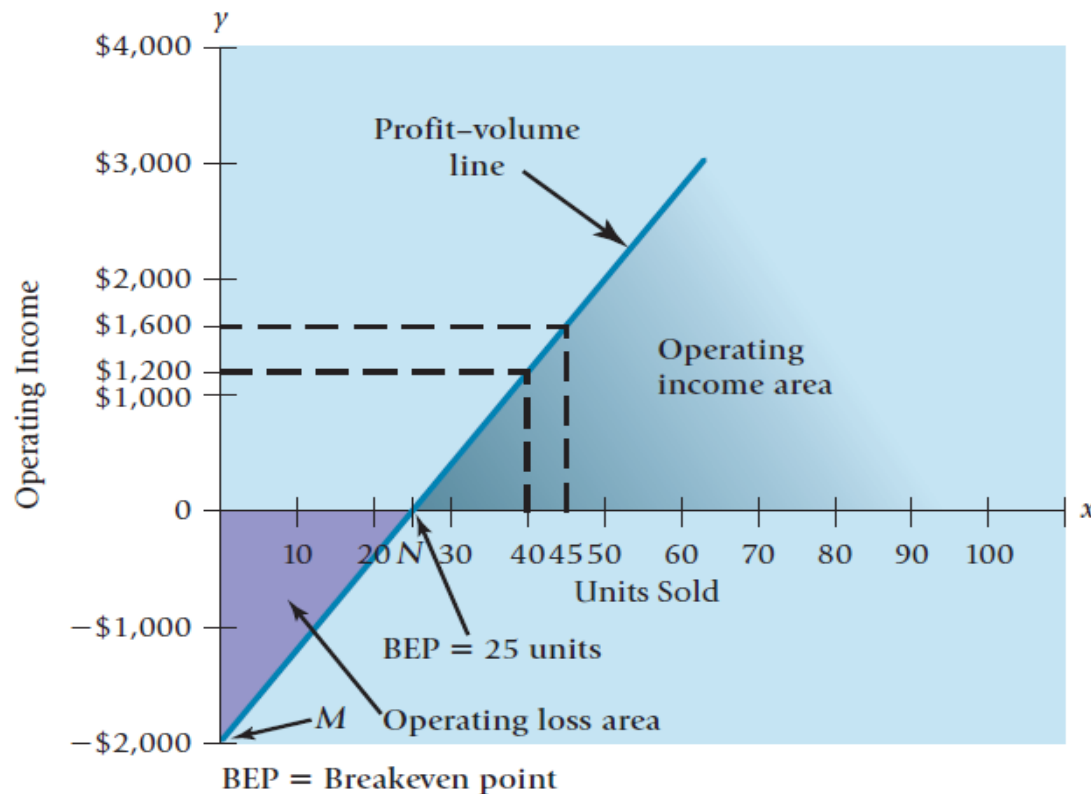
Qty of Units = (FC + Target Operating Income)/CM per unit

$$Q = (\$20,000 + \$30,000)/\$250$$

$$Q = 200$$

CVP: Graphically

EXHIBIT 3.3 Profit-Volume Graph for GMAT Success



CVP and Income Taxes

After-tax profit (Net Income) can be calculated by:

- $\text{Net Income} = \text{Operating Income} * (1 - \text{Tax Rate})$

Net income can be converted to operating income for use in the CVP equation

- $$\text{Operating Income} = \frac{\text{Net Income}}{(1 - \text{Tax Rate})}$$

Note: the CVP equation will continue to use operating income. We'll use this conversion formula to obtain the operating income value when provided with Net Income.

CVP and Income Taxes – Tiny's Cabinets

Net income can be converted to operating income for use in the CVP

$$\text{Equation Operating Income} = \frac{\text{Net Income}}{(1-\text{Tax Rate})}$$

What if Tiny wanted to earn \$30,000 Net Income instead of Operating Income? His tax rate is 35%.

Quantity of Units = (FC + Target Operating Income)/CM per unit

$$Q = (\$20,000 + [\$30,000/(1-35%)]/\$250$$

$$Q = (\$20,000 + \$46,154)/\$250 = 265$$

Using CVP Analysis for Decision Making (1 of 3)

Remember Tiny? As is, he expects to sell 100 cabinets. What if Tiny spent \$5,000 on advertising and estimated that it would increase his sales by 10%. Should he do it?

To find out, we can use CVP analysis as follows:

	Sales without Advertising	Sales with Advertising
Units Sold	100	110
Revenues (SP \$600)	\$60,000	\$66,000
Variable Cost (\$350)	\$35,000	\$38,500
Fixed Costs	\$20,000	\$25,000
Operating Income	\$ 5,000	\$ 2,500

Using CVP Analysis for Decision Making (2 of 3)

As we see from the prior screen, though Tiny's sales increase with the advertising expenditure, his Operating Income decreases by \$2,500.

Tiny will be better off if he doesn't advertise.

What if I told you that a more detailed analysis indicated that Tiny's sales would increase by 25% instead of 10%. Should he do it?

Here's a quick way to check that. If sales increase 25%, they'll increase by 25 units. 25 units X Contribution Margin per unit of \$250 ($\$600 - \350) = \$6,250.

That is \$1,250 greater than the \$5,000 Tiny would have to spend. So, in this case, Tiny will be better off spending money on the advertising.

Using CVP Analysis for Decision Making (3 of 3)

The concept of using CVP analysis for decision making works just as well if you are thinking about decreasing prices. If you decrease your price, you'd expect more unit sales. To determine if the combination of lower price with higher unit sales will improve Operating Income, use CVP analysis.

This type of strategic decision entails risk. We use CVP to evaluate how the Operating Income will change but we cannot be certain that our estimates of increased sales will occur.

Managers use electronic spreadsheets to systematically and efficiently conduct CVP-based sensitivity analysis to test how sensitive their conclusions are to different assumptions.

Sensitivity Analysis

- CVP provides structure to answer a variety of “what-if” scenarios.
- “What” happens to profit “if”:
 - Selling price changes
 - Volume changes
 - Cost structure changes
 - Variable cost per unit changes
 - Fixed costs change

As an example, if a company determines that an ad campaign costing \$15,000 is expected to increase sales 25%, should they proceed? This is very similar to the analysis we did for Tiny’s Cabinets. The question cannot be properly answered without doing this type of analysis.

Margin of Safety-Defined

- The margin of safety calculation answers a very important question:
- If budgeted revenues are above the breakeven point, how far can they fall before the breakeven point is reached.
- In other words, how far can they fall before the company will begin to lose money.

Margin of Safety – An Indicator of Risk

- The margin of safety (MOS) measures the distance between budgeted sales and breakeven (BE) sales:
- **MOS** = Budgeted Sales - BE Sales
- The MOS ratio removes the firm's size from the output and expresses itself in the form of a percentage:
- **MOS Ratio** = $\text{MOS} / \text{Budgeted Sales}$

Cost Structure

- Managers make strategic decisions that affect the cost structure of the company
- The cost structure is simply the relationship of fixed costs and variable costs to total costs.
- We can use CVP-based sensitivity analysis to highlight the risks and returns as fixed costs are substituted for variable costs in a company's cost structure.
- The risk-return trade-off across alternative cost structures can be measured as operating leverage.

Operating Leverage = $CM/Operating$ Income

- The risk-return tradeoff across alternative cost structure can be measured as operating leverage.
- Operating leverage describes the effects that fixed costs have on changes in operating income as changes occur in units sold and contribution margin.
- Organizations with a high proportion of fixed costs in their cost structures have high operating leverage.
- In the presence of fixed costs, the degree of operating leverage is different at different levels of sales.

Using Operating Leverage to Estimate Changes to Operating Income

- We can use Operating Leverage to estimate changes to Operating Income that will result from a percentage change in sales.
- Operating Leverage X % Change in Sales = Percentage change in Operating Income
- For example, if sales increase 50% and operating leverage is 1.67, you should expect operating income to increase 83.5% (50% x 1.67)

Effects of Sales Mix on CVP

- Sales Mix is the quantity or proportion of various products or services that constitute a company's total unit sales. It is often the case that the various products or services have different contribution margins.
- Up to this point, we've assumed a single product; more realistically, we'll have multiple products with different costs and different margins.
- We can use the same formula in our CVP calculations but must use an average contribution margin for the products.
- This technique assumes a constant mix at different levels of total unit sales.

CVP for Service and Not-For-Profit Organizations

- CVP isn't just for merchandising and manufacturing companies.
- Service and Not-For-Profit businesses need to focus on measuring their output which is different from the units sold that we've been dealing with.
- For example, a service agency might measure how many persons they assist or an airline might measure how many passenger miles they fly.
- What measure might a hotel use? A restaurant?

Contribution Margin versus Gross Margin

- Recall from Chapter 2 that $\text{Gross Margin} = \text{Revenue} - \text{Cost of Goods Sold}$
- In Chapter 3, we learned about Contribution Margin which is $\text{Revenue} - \text{All Variable Costs}$
- Gross Margin measures how much a company charges for its products over and above the cost of acquiring or producing them.
- Contribution Margin indicates how much of a company's revenue is available to cover fixed costs.
- This is especially significant in the manufacturing sector where businesses carry inventory

Contribution Margin and Gross Margin for Tiny's Cabinets (Produced 100 cabinets, sold 90; SP \$600; VC \$350; FC \$20,000 (15,000 Mfg))

Line Item	Contribution Margin	Line item	Gross Margin
Sales (90 * \$600)	\$54,000	Sales (90 * \$600)	\$54,000
Variable Costs (90*\$350)	\$31,500	Cost of Goods Sold (VCU \$350; FCU \$150)	\$45,000
Contribution Margin	\$22,500	Gross Margin	\$ 9,000
Fixed Mfg Costs	\$15,000	Non-Manufacturing Costs	\$ 5,000
Fixed Non-Mfg Costs	\$ 5,000		
Operating Income	\$ 2,500	Operating Income	\$4,000