CHAPTER 3

Cost-Volume-Profit Analysis

CHAPTER 3 LEARNING OBJECTIVES

1. Explain the features of cost-volume-profit (CVP) analysis
2. Determine the breakeven point and output level needed to achieve a target operating income
3. Understand how income taxes affect CVP analysis
4. Explain how managers use CVP analysis to make decisions

CHAPTER 3 LEARNING OBJECTIVES, CONT'D

5. Explain how sensitivity analysis helps managers cope with uncertainty
6. Use CVP analysis to plan variable and fixed costs
7. Apply CVP analysis to a company producing multiple products
8. Apply CVP analysis in service and not-for-profit organizations
9. Distinguish contribution margin from gross margin

WHAT IS CVP? HOW IS IT USED?

- 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 and 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

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

CVP: CONTRIBUTION MARGIN

- Manipulation of the basic equations yields an extremely important and powerful tool extensively used in cost accounting: contribution margin (CM).
- Contribution margin equals revenue less variable costs.
- Contribution margin per unit equals unit selling price less unit variable costs or can be obtained by taking contribution margin divided by number of units sold.

CVP: CONTRIBUTION MARGIN ADDITIONAL CALCULATIONS

You can also calculate:

- Contribution margin which is equal to the contribution margin per unit multiplied by the number of units sold.
- Contribution margin percentage which is the contribution margin per unit divided by unit selling price or Contribution margin divided by revenue.

COST-VOLUME-PROFIT EQUATION

REVENUE - VARIABLE COSTS - FIXED COSTS = OPERATING INCOME

(Selling Price * Quantity of Units Sold) - (Unit Variable Costs * Quantity of Units Sold) - Fixed Costs = Operating Income

Keep in mind the following:

Selling Price * Quantity of Units Sold = Revenue
Unit Variable Costs * Quantity of Units Sold = Variable Costs
Revenue - Variable Costs = Contribution Margin
Contribution Margin - Fixed Costs = Operating Income

BREAKEVEN POINT

- At the breakeven point, a firm has *no profit or loss* at the given sales level. Breakeven is where:
  - Sales – Variable Costs – Fixed Costs = 0
- Calculation of breakeven number of units
  - Breakeven Units = $\frac{\text{Fixed Costs}}{\text{Contribution Margin per Unit}}$
- Calculation of breakeven revenues
  - Breakeven Revenue = $\frac{\text{Fixed Costs}}{\text{Contribution Margin Percentage}}$

BREAKEVEN POINT, EXTENDED: PROFIT PLANNING

- The breakeven point formula can be modified to become a profit planning tool by adding Target Operating Income to fixed costs in the numerator.

$$\text{Quantity of Units Required to Be Sold} = \frac{\text{(Fixed Costs+Target Operating Income)}}{\text{Contribution Margin per Unit}}$$

LET'S REVIEW: EMMA

Emma has fixed costs of $2,000 and a contribution margin percentage of 40%.

If Emma wants to make a profit of $2,000, what must revenue equal?

What if Emma wants to make a profit of $3,000, what must revenue equal?

Remember the formula: (Fixed Cost+ Target Operating Income) / Contribution Margin %

Let's look at the details:

EMMA'S ANALYSIS FOR TARGET OPERATING INCOME

For OPERATING INCOME of $2,000

Revenue=(FC+TOI)/CM%

Revenue = (2,000+2,000)/.40 =

Revenue = $10,000

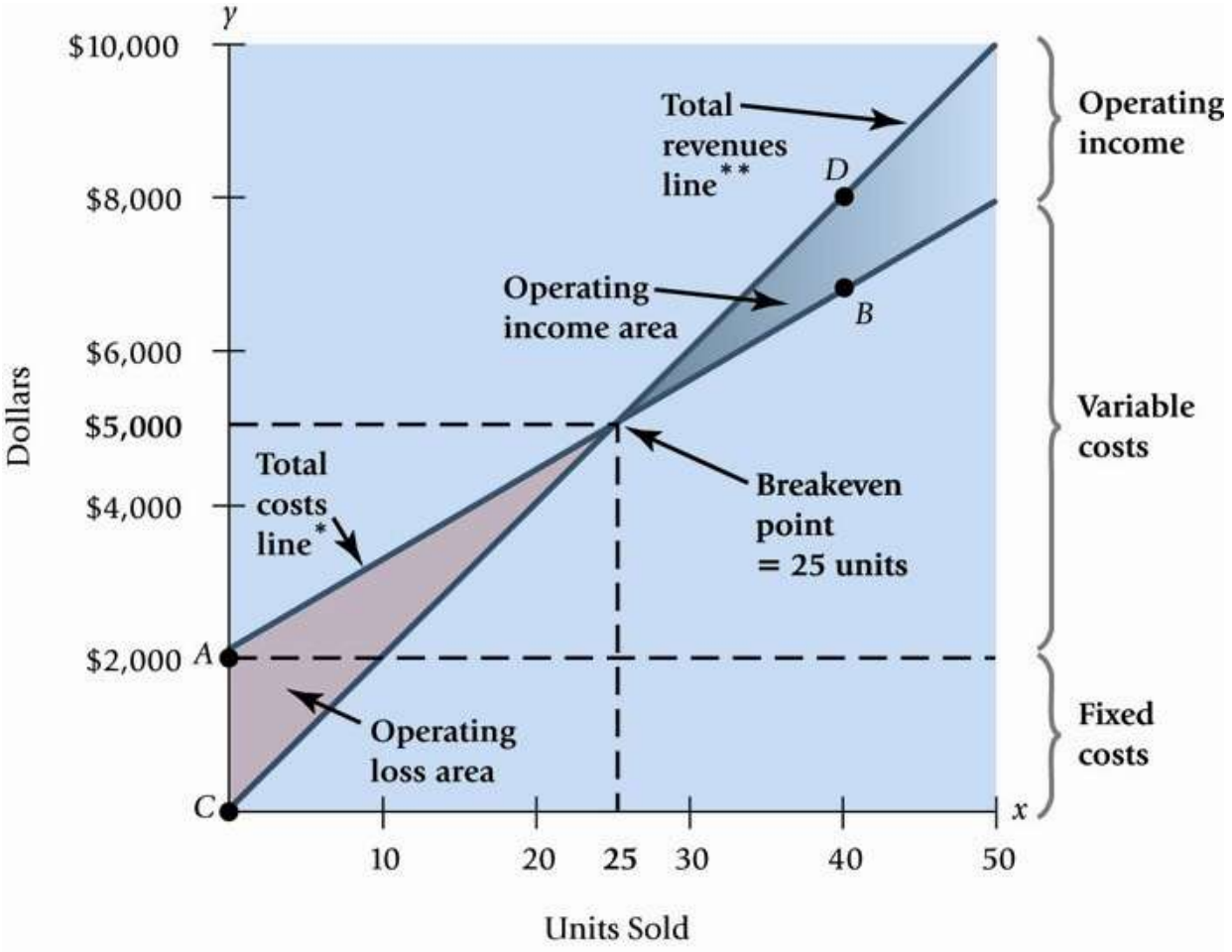
For OPERATING INCOME of $3,000

Revenue=(FC+TOI)/CM%

Revenue = (2,000+3,000)/.40 =

Revenue = $12,500

CVP: GRAPHICALLY



*Slope of the total costs line is the variable cost per unit = $120

**Slope of the total revenues line is the selling price = $200

CVP AND INCOME TAXES

- After-tax profit (Net Income) can be calculated by:
  - Net Income = Operating Income * (1-Tax Rate)
- Net income can be converted to operating income for use in 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.

DATE OF REACHING THE BREAKEVEN POINT

The Breakeven Point Date (BET) is calculated in either days or months as follows:

In days:

$$BET = (BER / Rev) \times 360$$

$$Or; BET = (BEQ / Q_{sold}) \times 360$$

In months:

$$BET = (BER / Rev) \times 12$$

$$Or; BET = (BEQ / Q_{sold}) \times 12$$

EXERCISE

Tuff Kids Jeans Co. sells blue jeans wholesale to major retailers across the country. Each pair of jeans has a selling price of $30 with $21 in variable costs of goods sold.

The company has fixed manufacturing costs of $1,200,000 and fixed marketing costs of $300,000. Sales commissions are paid to the wholesale sales reps at 5% of revenues. The company has an income tax rate of 25%.

1. How many jeans must Tuff Kids sell in order to break even?

2. How many jeans must the company sell in order to reach:

a. a target operating income of $450,000? What is the BET?

b. a net income of $450,000? What is the BET?

EXERCISE (CONT'D)

3. How many jeans would TuffKids have to sell to earn the net income $450,000 if: (consider each requirement independently).

a. The contribution margin per unit increases by 10%

b. The selling price is increased to $32.50

c. The company outsources manufacturing to an overseas company increasing variable costs per unit by $2.00 and saving 60% of fixed manufacturing costs.

PROFIT PLANNING, ILLUSTRATED

File Edit View Insert Format Tools Data Window Help

D5 fx =($A5+D$3)/(F1-$B5)

	A	B	C	D	E	F
1			Number of units required to be sold at $			200
2			Selling Price to Earn Target Operating Income of			
3		Variable Costs	$0	$1,200	$1,600	$2,000
4	Fixed Costs	per Unit	(Breakeven point)			
5	$2,000	$100	20	32[a]	36	40
6	$2,000	$120	25	40	45	50
7	$2,000	$150	40	64	72	80
8	$2,400	$100	24	36	40	44
9	$2,400	$120	30	45	50	55
10	$2,400	$150	48	72	80	88
11	$2,800	$100	28	40	44	48
12	$2,800	$120	35	50	55	60
13	$2,800	$150	56	80	88	96
14						

15–16 [a]Number of units required to be sold $= \frac{\text{Fixed costs + Target operating income}}{\text{Contribution margin per unit}} = \frac{\$2{,}000 + \$1{,}200}{\$200 - \$100} = 32$

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? That 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 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 = MOS ÷ Budgeted Sales

EXERCISE

Suppose Lattin Corp.'s breakeven point is revenues of $1,500,000. Fixed costs are $720,000.

1. Compute the contribution margin percentage.
2. Compute the selling price if variable costs are $13 per unit.
3. Suppose 90,000 units are sold. Compute the margin of safety in units and dollars.
4. What does this tell you about the risk of Lattin making a loss? What are the most likely reasons for this risk to increase?

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

- Operating leverage (OL) describes the effect that fixed costs have on changes in operating income as changes occur in units sold and contribution margin.
  - $OL = \frac{\text{Contribution Margin}}{\text{Operating Income}}$

Notice that the difference between the numerator and the denominator in our formula = our fixed costs.

USING OPERATING LEVERAGE TO ESTIMATE CHANGES IN OPERATING INCOME

The formula to estimate the change in operating income that will result from a percentage change in sales is:

Operating Leverage X % Change in Sales

If sales increase 50% and operating leverage is 1.67, you should expect operating income to increase 83.5%.

PROBLEM

Carmel Rugs is holding a 2-week carpet sale at Jean's Club, a local warehouse store. Carmel Rugs plans to sell carpets for $1,000 each. The company will purchase the carpets from a local distributor for $400 each, with the privilege of returning any unsold units for a full refund. Jean's Club has offered Carmel Rugs two payment alternatives for the use of space.

- Option 1: A fixed payment of $17,400 for the sale period
- Option 2: 20% of total revenues earned during the sale period

Assume Carmel Rugs will incur no other costs.

1. Calculate the breakeven point in units for (a) option 1 and (b) option 2.

2. At what level of revenues will Carmel Rugs earn the same operating income under either option?

a. For what range of unit sales will Carmel Rugs prefer option 1?

b. For what range of unit sales will Carmel Rugs prefer option 2?

3. Calculate the degree of operating leverage at sales of 87 units for the two rental options.

EFFECTS OF SALES MIX ON CVP

- The formulae presented to this point have assumed a single product is produced and sold.
- A more realistic scenario involves multiple products sold, in different volumes, with different costs and different margins.
- In this case, we use the same formulae, but use average contribution margins for the multiple 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.

ALTERNATIVE INCOME STATEMENT FORMATS-ESPECIALLY SIGNIFICANT IN THE MANUFACTURING SECTOR

Contribution Income Statement Emphasizing Contribution Margin (in 000s)			Financial Accounting Income Statement Emphasizing Gross Margin (in 000s)	
Revenues		$1,000	Revenues	$1,000
Variable manufacturing costs	$250		Cost of goods sold (variable manufacturing costs, $250 + fixed manufacturing costs, $160)	410
Variable nonmanufacturing costs	270	520		
Contribution margin		480	Gross margin	590
Fixed manufacturing costs	160		Nonmanufacturing costs	
Fixed nonmanufacturing costs	138	298	(variable, $270 + fixed $138)	408
Operating income		$ 182	Operating income	$ 182