
Cost-Volume-Profit Analysis

Cost-Volume-Profit **Assumptions** and Terminology

- 1 Changes in the level of revenues and costs arise only because of **changes in the number of product (or service) units** produced and sold.
- 2 Total costs can be divided into a **fixed** component and a component that is **variable** with respect to the level of output.
- 3 When graphed, the behavior of total revenues and total costs is linear (straight-line) in relation to output units within the relevant range (and time period).
- 4 The unit selling price, unit variable costs, and fixed costs are (assumed) known and constant.
- 5 The analysis either covers a single product or assumes that the sales mix when multiple products are sold will remain constant as the level of total units sold changes.
- 6 All revenues and costs are added and compared **without** taking into account the **time value of money**.

Cost-Volume-Profit Assumptions and Terminology

Operating income =

Total revenues from operations

– Cost of goods sold & operating costs

Net Income =

Operating income

+ Nonoperating revenues (such as interest revenue)

– Nonoperating costs (such as interest cost)

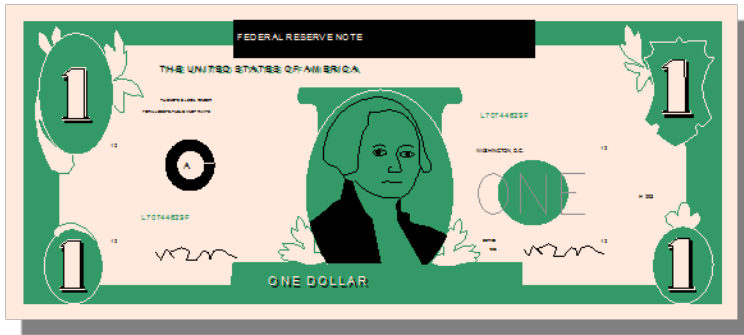
– Income taxes

Essentials of Cost-Volume-Profit (CVP) Analysis

- Assume that **Dresses by Mary** can purchase dresses for \$32 from a local factory; other variable costs amount to \$10 per dress.
- Because she plans to sell these dresses overseas, the local factory allows Mary to return all unsold dresses and receive a full \$32 refund per dress within one year.
- Mary can use CVP analysis to examine changes in operating income as a result of selling different quantities of dresses.
- Assume that the **average selling price** per dress is \$70 and **total fixed costs** amount to \$84,000.
- How much revenue will she receive if she sells 2,500 dresses?

Essentials of Cost-Volume-Profit (CVP) Analysis

- $2,500 \times \$70 = \$175,000$
- How much variable costs will she incur?
- $2,500 \times \$42 = \$105,000$
- Would she show an operating income or an operating loss?
- An operating loss
- $\$175,000 - 105,000 - 84,000 = (\$14,000)$



Essentials of Cost-Volume-Profit (CVP) Analysis

- The only numbers that change are total revenues and total variable cost.
- Total revenues – total variable costs
= **Contribution margin**
- Contribution margin per unit
= selling price – variable cost per unit
- What is Mary's contribution margin per unit?
 - $\$70 - \$42 = \$28$ contribution margin per unit
 - What is the total contribution margin when 2,500 dresses are sold?
 - $2,500 \times \$28 = \$70,000$
 - If Mary sells 3,000 dresses, revenues will be \$210,000 and contribution margin would equal $40\% \times \$210,000 = \$84,000$.

Breakeven Point...

- **is the sales level at which operating income is zero.**
- At the breakeven point, sales minus variable expenses equals fixed expenses.
- Total revenues = Total costs
- Breakeven can be computed by using either the equation method, the contribution margin method, or the graph method.

Abbreviations

- USP = Unit selling price
- UVC = Unit variable costs
- UCM = Unit contribution margin
- CM% = Contribution margin percentage
- FC = Fixed costs
- Q = Quantity of output (units sold or manufactured)
- OI = Operating income
- TOI = Target operating income
- TNI = Target net income

Calculate the BEP:

- Breakeven sales in units is calculated as follows:
- $(\text{Unit sales price} \times \text{Units sold}) - (\text{Variable unit cost} \times \text{units sold}) - \text{Fixed expenses} = \text{Operating income}$
- Breakeven sales units for Dresses by Mary:
 - $\$70Q - \$42Q - \$84,000 = 0$
 - $\$28Q = \$84,000$
 - $Q = \$84,000 \div \28
 - $Q = 3,000 \text{ units}$

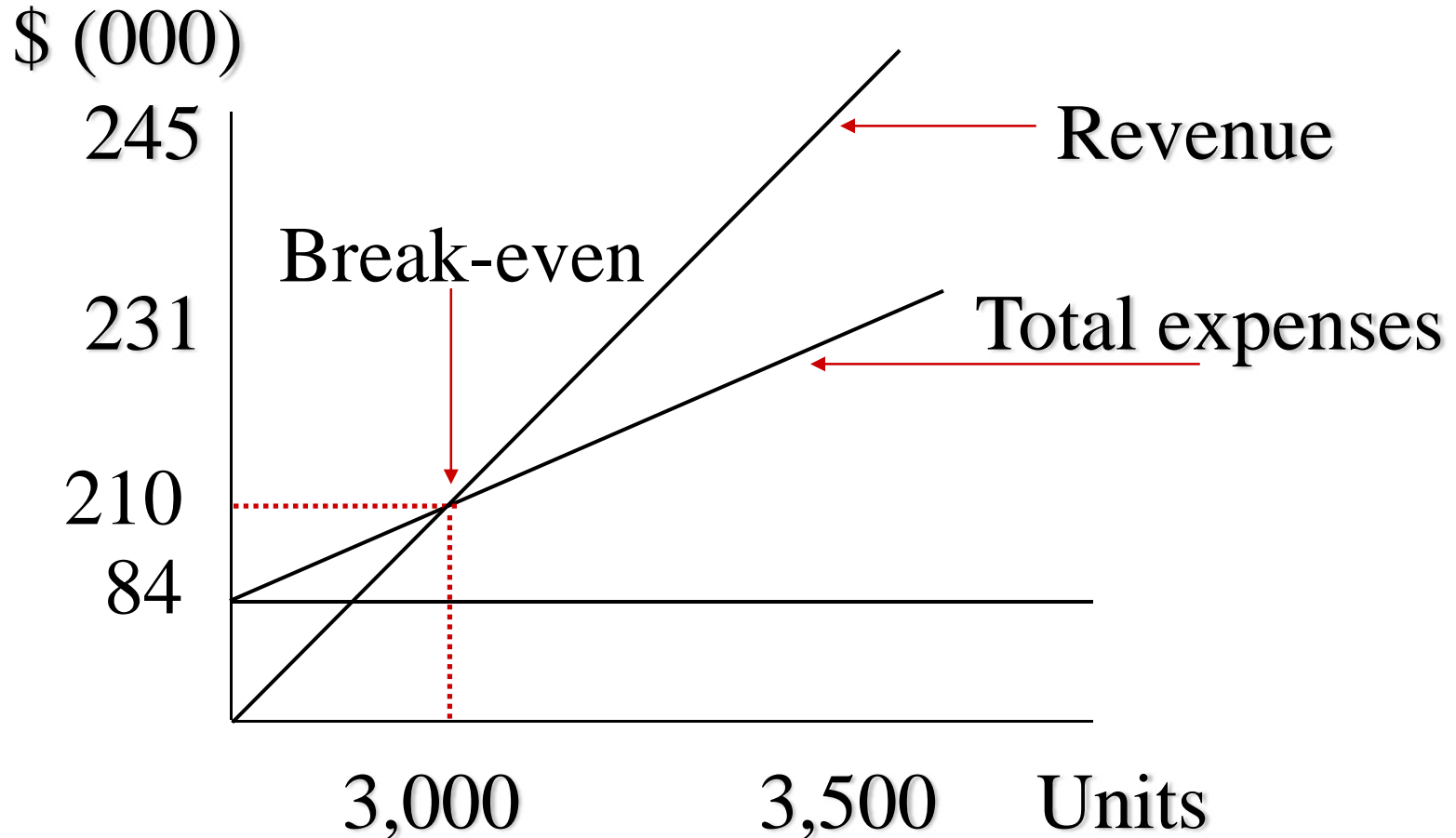
Alternative calculation:

- Focusing on the contribution margin, breakeven is calculated as follows:
- $(\text{USP} - \text{UVC}) \times Q = \text{FC}$
- $\text{UCM} \times Q = \text{FC}$
- $Q = \text{FC} \div \text{UCM}$
- $\$84,000 \div \$28 = 3,000$ units
- Using the contribution margin percentage, what is the breakeven point for Dresses by Mary in terms of revenue?
- $\$84,000 \div 40\% = \$210,000$

Graphical Solution:

- Plot a line for total revenues and total costs.
- The breakeven point is the point at which the total revenue line intersects the total cost line.
- The area between the two lines to the right of the breakeven point is the operating income area.

Graph Method Dresses by Mary



Target Operating Income

- Insert the target operating income in the formula and solve for target sales either in dollars or units.
 - (Fixed costs + Target operating income) divided either by Contribution margin percentage or Contribution margin per unit
 - Assume that Mary wants to have an operating income of \$14,000.
 - How many dresses must she sell?
 - $(\$84,000 + \$14,000) \div \$28 = 3,500$
 - What dollar sales are needed to achieve this income?
 - $(\$84,000 + \$14,000) \div 40\% = \$245,000$
-

Target Net Income and Income Taxes

- When managers want to know the effect of their decisions on income after taxes, CVP calculations must be stated in terms of target net income instead of target operating income.



Target Net Income and Income Taxes

- Management of Dresses by Mary would like to earn an after tax income of \$35,711.
 - The tax rate is 30%.
- What is the target operating income?
 - Target operating income = Target net income \div (1 – tax rate)
 - TOI = \$35,711 \div (1 – 0.30)
 - TOI = \$51,016
- How many units must she sell?
 - Revenues – Variable costs – Fixed costs = Target net income \div (1 – tax rate)
 - \$70Q – \$42Q – \$84,000 = \$35,711 \div 0.70
 - Q = \$135,016 \div \$28 = 4,822 dresses

Target Net Income and Income Taxes

Proof:

Revenues: $4,822 \times \$70$	\$337,540
Variable costs: $4,822 \times \$42$	<u>202,524</u>
Contribution margin	135,016
Fixed costs	<u>84,000</u>
Operating income	51,016
Income taxes: $\$51,016 \times 30\%$	<u>15,305</u>
Net income	\$ 35,711

Using CVP Analysis

- Suppose the management of Dresses by Mary anticipates selling 3,200 dresses. Management is considering an advertising campaign that would cost \$10,000. It is anticipated that the advertising will increase sales to 4,000 dresses.

- Should Mary advertise?

- 3,200 dresses sold with no advertising:

• Contribution margin	\$89,600
Fixed costs	<u>84,000</u>
Operating income	\$ 5,600

- 4,000 dresses sold with advertising:

• Contribution margin	\$112,000
Fixed costs	<u>94,000</u>
Operating income	\$ 18,000

- Mary should advertise.
- Operating income increases by \$12,400.
- The \$10,000 increase in fixed costs is offset by the \$22,400 increase in the contribution margin.

Using CVP Analysis

- Instead of advertising, management is considering reducing the selling price to \$61 per dress.
- It is anticipated that this will increase sales to 4,500 dresses.
- Should Mary decrease the selling price per dress to \$61?

3,200 dresses sold with no change in the selling price:

- Operating income \$ 5,600

4,500 dresses sold at a reduced selling price:

- Contribution margin: $(4,500 \times \$19)$ \$85,500

Fixed costs 84,000

Operating income \$ 1,500

- The selling price should not be reduced to \$61.
- Operating income decreases from \$5,600 to \$1,500.

Sensitivity Analysis and Uncertainty

- Sensitivity analysis is a “what if “ technique that examines how a result will change if the original predicted data are not achieved or if an underlying assumption changes.



Sensitivity Analysis and Uncertainty

- Assume that Dresses by Mary can sell 4,000 dresses.
 - Fixed costs are \$84,000.
 - Contribution margin ratio is 40%.
 - At the present time Mary cannot handle more than 3,500 dresses.
- To satisfy a demand for 4,000 dresses, management must acquire additional space for \$6,000.
 - Should the additional space be acquired?
 - Operating income at \$245,000 revenues with existing space = $(\$245,000 \times .40) - \$84,000 = \$14,000$.
 - $(3,500 \text{ dresses} \times \$28) - \$84,000 = \$14,000$
 - Operating income at \$280,000 revenues with additional space = $(\$280,000 \times .40) - \$90,000 = \$22,000$.
 - $(4,000 \text{ dresses} \times \$28) - \$90,000 = \$22,000$

Alternative Fixed/Variable Cost Structures

- Suppose that the factory Dresses by Mary is using to obtain the merchandise offers Mary the following:
 - Decrease the price they charge Mary from \$32 to \$25 and charge an annual administrative fee of \$30,000.
 - What is the new contribution margin? $\$70 - (\$25 + \$10) = \35
 - Contribution margin increases from \$28 to \$35.
 - What is the contribution margin percentage? $\$35 \div \$70 = 50\%$
 - What are the new fixed costs? $\$84,000 + \$30,000 = \$114,000$

Alternative Fixed/Variable Cost Structures

- Management questions what sales volume would yield an identical operating income regardless of the arrangement.
 - $28Q - 84,000 = 35Q - 114,000$
 - $7Q = 30,000$
 - $Q = 4,286$ dresses

Cost with existing arrangement = Cost with new arrangement

- $.60X + 84,000 = .50X + 114,000$
- $.10X = \$30,000$
- $X = \$300,000$
- $(\$300,000 \times .40) - \$84,000 = \$36,000$
- $(\$300,000 \times .50) - \$114,000 = \$36,000$

Operating Leverage...

- measures the relationship between a company's variable and fixed expenses.
- The degree of operating leverage shows how a percentage change in sales volume affects income.
- Degree of operating leverage = $\text{Contribution margin} \div \text{Operating income}$

Operating Leverage...

- What is the degree of operating leverage of Dresses by Mary at the 3,500 sales level under both arrangements?
- Existing arrangement:
 - $3,500 \times \$28 = \$98,000$ contribution margin
 - $\$98,000$ contribution margin – $\$84,000$ fixed costs = $\$14,000$ operating income
 - $\$98,000 \div \$14,000 = 7.0$
- New arrangement:
 - $3,500 \times \$35 = \$122,500$ contribution margin
 - $\$122,500$ contribution margin – $\$114,000$ fixed costs = $\$8,500$
 - $\$122,500 \div \$8,500 = 14.4$

Operating Leverage

- Caveat: as the degree of operating leverage shows how a percentage change in sales volume affects income it is sometimes taken as a measure of how „secure“ the business is
- This interpretation is fallacious.
- OL does not tell how likely or unlikely these changes are!

Effects of Sales Mix on Income

Sales mix is the combination of products that a business sells.

- Assume that Dresses by Mary is considering selling blouses.
 - This will not require any additional fixed costs.
 - It expects to sell **2 blouses at \$20 each for every dress it sells.**
 - The variable cost per blouse is \$9.
- What is the new breakeven point?
 - The contribution margin per dress is \$28 (\$70 selling price – \$42 variable cost).
 - The contribution margin per blouse is $\$20 - \$9 = \$11$.
 - The contribution margin of the mix is $\$28 + (2 \times \$11) = \$28 + \$22 = \$50$.



Contribution Margin versus Gross Margin

- Contribution income statement emphasizes contribution margin.
 - Revenues – Variable cost of goods sold – Variable operating costs = **Contribution margin**
 - Contribution margin – Fixed operating costs = **Operating income**
- Financial accounting income statement emphasizes gross margin.
 - Revenues – Cost of goods sold = **Gross margin**
 - Gross margin – Operating costs = **Operating income**

Multiple Cost Drivers

- Some aspects of CVP analysis can be adapted to the more general case of multiple cost drivers.
 - Suppose that Dresses by Mary will incur an additional cost of \$10 for preparing documents associated with the sale of dresses to various customers.
 - Assume that she sells 3,500 dresses to 100 different customers.
 - What is the operating income from this sale?
 - Operating income = Revenues – (Variable cost per dress × No. of dresses) – (Cost of preparing documents × No. of customers) – Fixed costs
-

Multiple Cost Drivers

What is the operating income from this sale?

- Operating income =
Revenues – (Variable cost per dress × No. of dresses)
– (Cost of preparing documents × No. of customers) – Fixed costs

• Revenues: 3,500 × \$70		\$245,000
Variable costs:		
Dresses: 3,500 × \$42	147,000	
Documents: 100 × \$10	<u>1,000</u>	
Total		<u>148,000</u>
Contribution margin		97,000
Fixed costs		<u>84,000</u>
Operating income		\$ 13,000

Multiple Cost Drivers

- Would the operating income of Dresses by Mary be lower or higher if Mary sells dresses to more customers?
- Mary's cost structure depends on two cost drivers:
 - 1 Number of dresses
 - 2 Number of customers



True or False???

- A cost driver is any factor that affects revenues.
- The breakeven point is where the total output revenue equals total output costs.
- When the firm wants to determine a target profit after taxes rather than before taxes, the number of units it needs to sell always increases.
- All other factors held constant, a change in sales mix will cause a change in the breakeven point for a multiple product firm.
- CVP analysis can only be applied to merchandising companies.

Financial Times, 16 July 2003:

Lucent Technologies, a manufacturer of routers and switching gear, warned of a larger-than-expected loss for the third quarter. Lucent management had expected the company to begin breaking even by the end of the current fiscal year, but now estimates to break even sometime in the next fiscal year which begins this September. The company, which has suffered from a collapse in telecommunications spending, has struggled through 12 consecutive quarters of losses. The reason for the current quarter's loss is that revenues are 18 percent less (\$2.4 million) than they were in the second quarter. According to Frank D'Amelio, Lucent's chief financial officer, the revenue shortfall is due to spending cuts by North American wireless carriers and an unexpected delay in a network contract.

Lucent management is struggling to reduce its break-even point which is currently \$2.4 billion. One way to accomplish that goal is through further job cuts. The number of employees at Lucent was 106,000 at one time; now, that number is being slashed to 35,000. The company may be forced to rethink its strategy of being a wide-ranging equipment supplier.

Because of consecutive quarterly losses, the announcement of the current quarter's expected loss, and the extension of the break-even target date, Standard and Poor's has threatened to further downgrade the company's credit rating, which is already at junk status at B-minus.

TALKING IT OVER AND THINKING IT THROUGH!

1. What is meant by the term "break-even point"? How is the break-even point computed?
2. Lucent warned of an 18 percent drop in quarterly revenues. What effect does this expected drop in revenues have on the break-even point?
3. The lowered revenue forecast raises the risk of further job cuts at Lucent. What effect will job cuts have on the break-even point?
4. Explain three ways Lucent could lower its break-even point?