

# CHAPTER 3

## Cost-Volume-Profit (CVP) Analysis

# Basic Assumptions

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- 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)

# Basic Assumptions, continued

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- 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

# Basic Formulae

		<b>Total</b>		<b>Cost</b>		<b>Pretax</b>
<b>Operating</b>		<b>Revenues</b>	<b>—</b>	<b>of</b>	<b>—</b>	<b>Operating</b>
<b>Income</b>	<b>=</b>	<b>from</b>		<b>Goods</b>		<b>Expenses</b>
		<b>Operations</b>		<b>Sold</b>		

<b>Net</b>		<b>Operating</b>	<b>—</b>	<b>Income</b>
<b>Income</b>	<b>=</b>	<b>Income</b>		<b>Taxes</b>

# Contribution Margin

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- Contribution Margin equals sales less variable costs
  - $CM = S - VC$
- Contribution Margin per unit equals unit selling price less variable cost per unit
  - $CM_u = SP - VC_u$

# Contribution Margin

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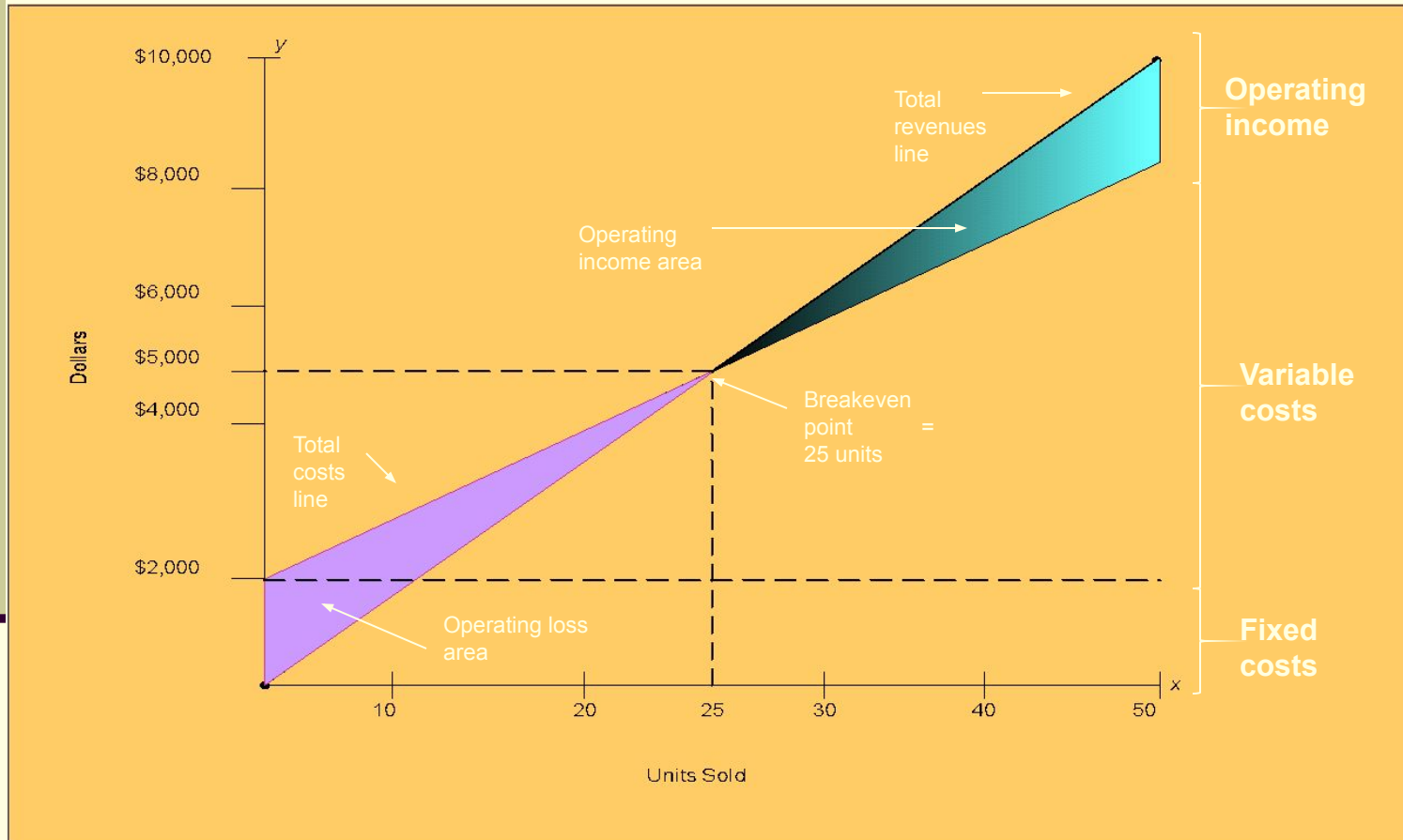
- Contribution Margin also equals contribution margin per unit multiplied by the number of units sold
  - $CM = CM_u \times Q$
- Contribution Margin Ratio (percentage) equals contribution margin per unit divided by selling price
  - $CMR = CM_u \div SP$

# Contribution Margin Income Statement Derivations

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- A horizontal presentation of the Contribution Margin Income Statement:
- $\text{Sales} - \text{VC} - \text{FC} = \text{Operating Income (OI)}$
- $(\text{SP} \times \text{Q}) - (\text{VC}_u \times \text{Q}) - \text{FC} = \text{OI}$
- $\text{Q} (\text{SP} - \text{VC}_u) - \text{FC} = \text{OI}$
- $\text{Q} (\text{CM}_u) - \text{FC} = \text{OI}$ 
  - Remember this last equation, it will be used again in a moment

# CVP, Graphically





# Breakeven Point

- Recall the last equation in an earlier slide:
  - $Q (CM_u) - FC = OI$
- A simple manipulation of this formula, and setting OI to zero will result in the Breakeven Point (quantity):
  - $BEQ = FC \div CM_u$
- At this point, a firm has no profit or loss at a given sales level

# Breakeven Point, continued

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- If per-unit values are not available, the Breakeven Point may be restated in its alternate format:
- $BE \text{ Sales} = FC \div CMR$

# Breakeven Point, extended: Profit Planning

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- With a simple adjustment, the Breakeven Point formula can be modified to become a Profit Planning tool
  - Profit is now reinstated to the BE formula, changing it to a simple sales volume equation
  - $Q = \frac{(FC + OI)}{CM}$

# CVP and Income Taxes

- From time to time it is necessary to move back and forth between pre-tax profit (OI) and after-tax profit (NI), depending on the facts presented
- After-tax profit can be calculated by:
  - $OI \times (1 - \text{Tax Rate}) = NI$
- NI can substitute into the profit planning equation through this form:
  - $OI = \frac{NI}{(1 - \text{Tax Rate})}$

# Sensitivity Analysis

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- 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 cost changes

# Margin of Safety

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- One indicator of risk, the Margin of Safety (MOS) measures the distance between budgeted sales and breakeven sales:
  - $MOS = \text{Budgeted Sales} - \text{BE Sales}$
- The MOS Ratio removes the firm's size from the output, and expresses itself in the form of a percentage:
  - $MOS \text{ Ratio} = MOS \div \text{Budgeted Sales}$

# Operating Leverage

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- Operating Leverage (OL) is the effect that fixed costs have on changes in operating income as changes occur in units sold, expressed as changes in contribution margin
  - $OL = \frac{\text{Contribution Margin}}{\text{Operating Income}}$
  - Notice these two items are identical, except for fixed costs

# Effects of Sales-Mix on CVP

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- 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
- For simplicity's sake, only two products will be presented, but this could easily be extended to even more products



# Effects of Sales-Mix on CVP

- A weighted-average CM must be calculated (in this case, for two products)

$$\text{Weighted Average CMu} = \frac{(\text{Product \#1 CMu} \times \text{Product \#1 Q}) + (\text{Product \#2 CMu} \times \text{Product \#2 Q})}{\text{Total Units Sold (Q) for Both Products}}$$

- This new CM would be used in CVP equations

Multi-		Fixed Costs
Product	=	Weighted Average CM per unit
BE		

# Multiple Cost Drivers

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- Variable costs may arise from multiple cost drivers or activities. A separate variable cost needs to be calculated for each driver.

Examples include:

- Customer or patient count
- Passenger miles
- Patient days
- Student credit-hours

# Contribution Margin vs. Gross Profit Comparative Statements

## Contribution Margin Income Statement (Internal-Use Only)

Revenues:		\$200
Less:		
Variable Cost of Goods Sold	\$120	
Variable Operating Costs	45	165
Contribution Margin		<u>35</u>
Fixed Operating Costs		<u>20</u>
Operating Income		<u>\$15</u>

## Financial Accounting Income Statement GAAP - Based

Revenues:		\$200
Less:		
Cost of Goods Sold	\$120	
Gross Margin (Profit)		80
Fixed & Variable Operating Costs		<u>65</u>
Operating Income		<u>\$15</u>