

Cost-volume-profit analysis (CVP Analysis).

The first learning objective is to identify how changes in volume affect costs.

Some costs increase as the volume of activity increases. Other costs are not affected by volume changes. Managers need to know how a business's costs are affected by changes in its volume of activity. Let us look at the three different types of costs:

- Variable costs
- Fixed costs
- Mixed costs

Total variable costs change in direct proportion to changes in the volume of activity. An activity is a business action that affects costs. Those activities include selling, producing, driving, and calling. These activities can be measured by units sold, units produced, miles driven, and the number of phone calls placed. So variable costs are those costs that increase or decrease in total as the volume of activity increases or decreases. Total variable costs increase as activity increases, but the variable cost per unit does not change.

Units produced	Direct materials cost per unit	Total direct materials cost
100	\$25	\$2,500
200	\$25	5,000
300	\$25	7,500
400	\$25	10,000
500	\$25	12,500

This table demonstrates this concept. Direct materials is a variable cost. The more production that occurs, the more direct materials that are needed. Notice that the direct materials cost per unit stays constant at \$25, but the total direct materials cost increases proportionately with production.

In contrast, total fixed costs are costs that do not change over wide ranges of volume. Fixed costs include straight-line depreciation and salaries. Total fixed cost does not change, but the fixed cost per unit depends on the number of units. The fixed cost per unit is inversely proportional to the level of activity.

Mixed Costs: Costs that have both variable and fixed components are called mixed costs.

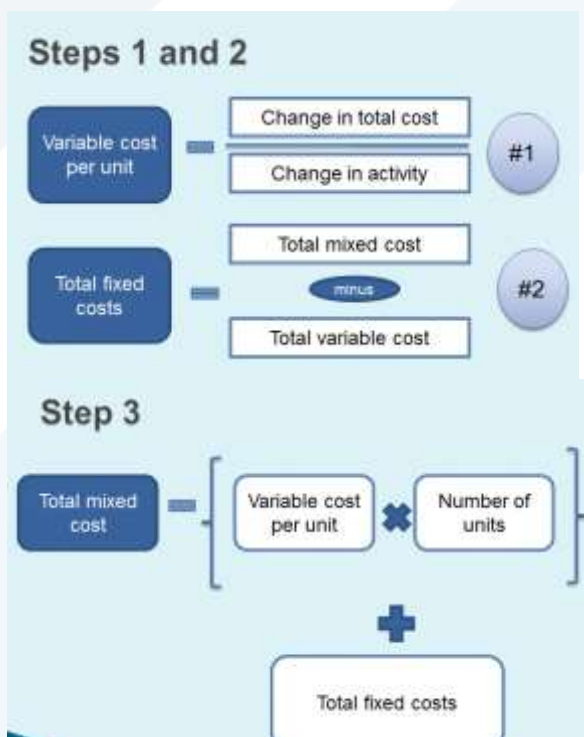
► Example:

- Utilities that charge a set fee per month, plus a charge for usage

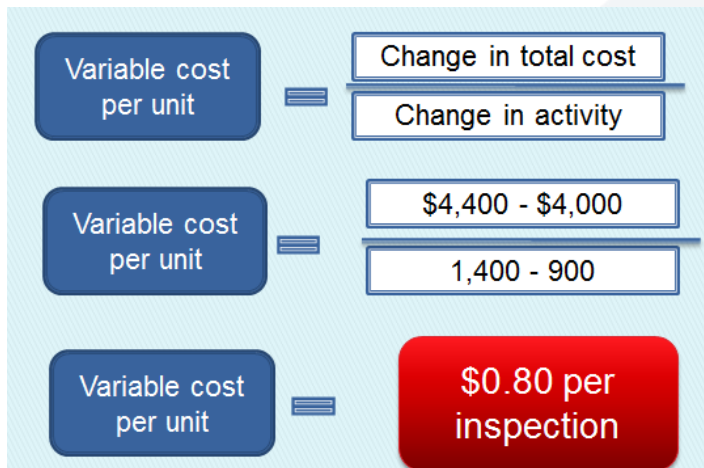
An easy method to separate mixed costs into variable and fixed components is the high-low method. This method requires you to identify the highest and lowest levels of activity over a period of time.

There are three steps to complete the high-low method.

First, variable cost per unit is computed. That amount is used to determine the total fixed costs. Then, an equation is created to show the cost behavior.



Example: The manager of Swift Car Inspection reviewed his monthly operating costs for the past year. His costs ranged from \$4,400 for 1,400 inspections to \$4,000 for 900 inspections. To determine the variable cost per unit, the change in cost, \$400, is divided by the 500-unit change in inspections. The result is a variable cost per inspection of 80 cents.



Therefore, the cost formula for inspection is \$0.80 cents per inspection plus \$3,280 fixed cost. If 1,000 inspections are completed, the estimate would be a total cost of \$4,080.



Jenny was reviewing the water bill for her doggy day spa and determined that her highest bill, \$3,000, occurred in July when she washed 2,000 dogs and her lowest bill, \$2,000, occurred in November when she washed 1,000 dogs.

What was the variable cost per dog wash associated with Jenny's water bill?

$$\frac{3000-2000}{2000-1000} = \frac{1000}{1000} = 1$$

What was the fixed cost associated with Jenny's water bill?

	At highest level	At lowest level
Variable Cost	2000 × 1 = 2000	1000 × 1 = 1000
Fixed Cost	3000 - 2000 = 1000	2000 - 1000 = 1000
Total	3000	2000



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Relevant range

The relevant range is the band of volume where total fixed costs remain constant and the variable cost per unit remains constant. To estimate costs, managers need to know the relevant range. Why? Because:

- total “fixed” costs can differ from one relevant range to another
- the variable cost per unit can differ in various relevant ranges

The second learning objective is to use CVP analysis to compute breakeven points.

CVP analysis assumes that:

1. managers can classify each cost as either variable or fixed, and
2. the only factor that affects costs is change in volume. Fixed costs don't change.

Most business conditions do not perfectly meet these assumptions (consider that most businesses have some mixed costs), so managers regard CVP analysis as approximate, not exact.

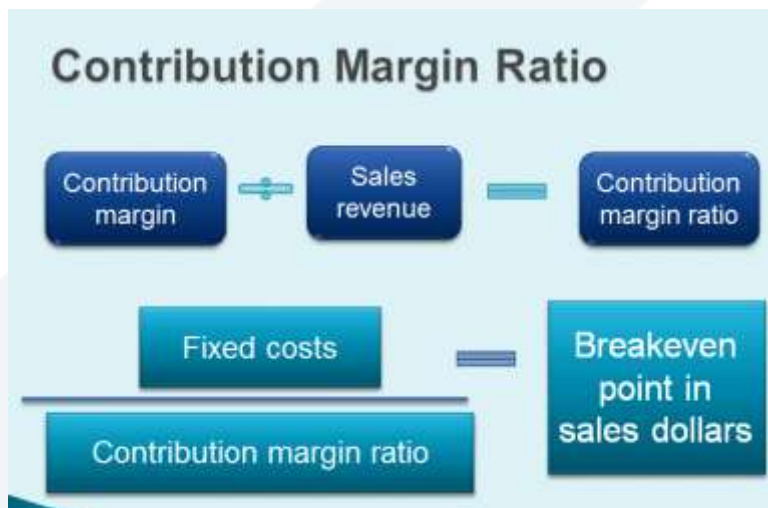
Breakeven point

Virtually all businesses want to know their breakeven point. The breakeven point is the sales level at which operating income is zero — total revenues equal total costs. Sales below the breakeven point result in a loss. Sales above breakeven provide a profit.

There are several ways to figure the breakeven point, including the:

- Income statement approach
- Contribution margin approach





The third learning objective is to use CVP analysis for profit planning

For established products and services, managers are more interested in the sales level needed to earn a target profit than in the breakeven point. Managers of new business ventures are also interested in the profits they can expect to earn. To determine a target income, the breakeven formula is adjusted to add the desired operating income to fixed costs in the numerator. Then, to determine the sales dollars necessary to earn the target, divide by the contribution margin ratio.



1) Pennell Company gathered the following information for the year ended December 31, 2009:

<u>Fixed costs:</u>		<u>Variable costs:</u>	
Manufacturing	\$165,000	Manufacturing	\$113,000
Marketing	\$52,000	Marketing	\$39,000
Administrative	\$24,000	Administrative	\$48,000

During the year, Pennell produced and sold **75,000** units of product at a sale price of **\$6.50** per unit. What is the contribution margin?

What is the operating income (loss)?

Income statement	
Sales revenue (75000× 6.5)	487500
-Variable cost	(200000)
Contribution margin	<u>287500</u>
- operating expenses	(241000)
Operating income	<u>46500</u>

2) Canine Company produces and sells dog treats for discriminating pet owners. The unit selling price is \$10, unit variable costs are \$7, and total fixed costs are \$3,300. How many dog treats must Canine Company sell to breakeven?

$$\text{Breakeven Point} = \frac{\text{Fixed cost}}{\text{Contribution margin}}$$

$$\text{Breakeven Point} = \frac{3300}{10-7} = 1100 \text{ units}$$

What is the breakeven point in sales dollars?

$$\text{Breakeven Point in Dollars} = \frac{\text{Fixed cost}}{\text{Contribution margin Ratio}}$$

$$\text{Breakeven Point} = \frac{3300}{0.3} = \$11000$$

3) Assuming 10,000 units are sold

Total fixed costs	\$15,000
Sale price per unit	\$23
Variable costs per unit	\$15

What is the contribution margin? $(23-15) \times 10000 = 80000$

What is the operating income? Contribution margin – fixed cost = $80000 - 15000 = 65000$

If sales revenue per unit increases to \$25 and 10,000 units are sold, what is the contribution margin?
 $(25-15) \times 10000 = 100000$

4) The Pearson Company has a contribution margin ratio of 25%. Pearson's operating income was \$100,000 when sales totaled \$1,000,000. What were Pearson's fixed expenses?

Income statement	
Sales revenue (75000 × 6.5)	1,000,000
-Variable cost	(?)
Contribution margin 25%	?
- Fixed expenses	(?)
Operating income	100,000

Contribution margin = $1,000,000 \times 25\% = 250,000$

Operating income = contribution margin - fixed cost $\Rightarrow 100000 = 250000 - ?$

\Rightarrow fixed cost = 150000

5) If the sales price per unit is \$32, total fixed expenses are \$45,000 and the breakeven sales in dollars is \$180,000, what is the variable expense per unit?

$$\begin{aligned} \text{Breakeven Point in Dollars} &= \frac{\text{Fixed cost}}{\text{Contribution margin Ratio}} \\ \text{Breakeven Point} &= \frac{45000}{?} = \$180000 \end{aligned}$$

Contribution margin Ratio = 0.25

$$\text{Contribution margin Ratio} = \frac{\text{Sales price per unit} - \text{variable cost}}{\text{Sales price per unit}} = \frac{32 - ?}{32} = 0.25$$

Variable cost per unit = 24

6) Belton Company currently sells its products for \$25 per unit. Management is contemplating a 20% increase in the sales price for next year. Variable costs are currently 30% of sales revenue and are not expected to change next year. Fixed expenses are \$150,000.

What is the breakeven point in units at the current sales price?

$$\begin{aligned} \text{Breakeven Point} &= \frac{\text{Fixed cost}}{\text{Contribution margin}} \\ \text{Breakeven Point} &= \frac{\$150,000}{25 - 7.5} = 8571 \text{ units} \end{aligned}$$

What is the breakeven point in units at the anticipated sales price **next year**?

$$\begin{aligned} \text{Breakeven Point} &= \frac{\text{Fixed cost}}{\text{Contribution margin}} \\ \text{Breakeven Point} &= \frac{\$150,000}{30 - (30 \times 30\%)} = 7143 \text{ units} \end{aligned}$$

If fixed costs were to increase 10% next year, and the new sales price goes into effect, what is the breakeven point in units?

$$\begin{aligned} \text{Breakeven Point} &= \frac{\text{Fixed cost}}{\text{Contribution margin}} \\ \text{Breakeven Point} &= \frac{\$165,000}{30 - (30 \times 30\%)} = 7857 \text{ units} \end{aligned}$$

7) What impact would an **increase in fixed costs** have on the contribution margin, the margin of safety and the breakeven point?

<u>contribution margin</u>	<u>margin of safety</u>	<u>breakeven point</u>
<u>No effect</u>	<u>Decrease</u>	<u>Increase</u>

8) Dakota Company provides the following information about its single product:

Targeted operating income	\$40,000
Selling price per unit	\$3.50
Variable cost per unit	\$1.05
Total fixed costs	\$90,000

What is the contribution margin ratio?

$$(3.50 - 1.05) / 3.50 = 0.70$$

9) Marino Company's average manufacturing cost was \$5.40 when 50,000 units were manufactured and was \$5.25 when 80,000 units were manufactured. How much was Marino's variable cost per unit?

Average cost	units	Total cost
\$5.4	× 50,000	=270,000
\$5.25	×80,000	=420,000
Change	30,000	150,000

$$\text{Variable cost per unit} = \frac{\text{Change in total cost}}{\text{Change in activity}} = \frac{420,000 - 270,000}{80,000 - 50,000} = 5$$

10) Total fixed costs for JB Company are \$300,000. Total costs, both fixed and variable, are \$378,000 for JB Company when 40,000 units are produced. Calculate the following:

- variable cost per unit
- fixed cost per unit

Answer:

- \$378,000 - \$300,000 = \$78,000
\$78,000/40,000 = \$1.95
- \$300,000/40,000 = \$7.50

11) Total fixed costs for Horton Company are \$200,000. Total costs, both fixed and variable, are \$450,000 if 125,000 units are produced. Calculate the following:

- variable cost per unit
- fixed cost per unit if 125,000 units are produced
- total variable costs if production decreases to 100,000 units

Answer:

- \$450,000 - \$200,000 = \$250,000
\$250,000/125,000 = \$2.00
- \$200,000/125,000 = \$1.60
- 100,000 × \$2 = \$200,000

12) Total variable costs are \$400,000 if 50,000 units are produced. Total fixed costs are \$150,000 if 35,000 units are produced. Calculate the following:

- a) unit variable cost
- b) fixed cost per unit if 35,000 units are produced
- c) total variable costs if 35,000 units are produced

- a) $\$400,000/50,000 = \8.00
- b) $\$150,000/35,000 = \4.29 (rounded)
- c) $\$8 \times 35,000 = \$280,000$

13) Mars Company has calculated its annual total fixed costs to be \$75,000. Production for recent years has averaged 40,000 units with total variable costs of \$120,000. Based on the foregoing data, complete the table below. Assume all activity levels are within the relevant range.

Activity Level	Total Fixed Costs	Unit Fixed Cost	Total Variable Costs	Unit Variable Costs
20,000				
30,000				
40,000				
55,000				
80,000				

Answer:

Activity Level	Total Fixed Costs	Unit Fixed Cost	Total Variable Costs	Unit Variable Costs
20,000	\$75,000	\$3.75	\$60,000	\$3
30,000	\$75,000	\$2.50	\$90,000	\$3
40,000	\$75,000	\$1.88	\$120,000	\$3
55,000	\$75,000	\$1.36	\$165,000	\$3
80,000	\$75,000	\$0.94	\$240,000	\$3

14) Calculate the unknowns for the following situations based on the given data.

Actual total sales revenue	\$400,000
Total fixed cost	\$75,000
Unit variable cost	\$15
Contribution margin ratio	40%

Calculate the:

- breakeven point in sales dollars
- unit selling price
- unit contribution margin
- breakeven point in units
- margin of safety

Answer:

- $\$75,000 / .40 = \$187,500$
- $\$15 / .60 = \25
- $\$25 \times .40 = \10
- $\$75,000 / \$10 = 7,500$ units
- $\$400,000 - \$187,500 = \$212,500$

15) Pennell Company gathered the following information for the year ended December 31, 2009:

Fixed costs:	
Manufacturing	\$165,000
Marketing	\$52,000
Administrative	\$24,000
Variable costs:	
Manufacturing	\$113,000
Marketing	\$39,000
Administrative	\$48,000

During the year, Pennell produced and sold 75,000 units of product at a sale price of \$6.50 per unit. What is the contribution margin?

Calculations: $(75,000 \times \$6.50) - (113,000 + 39,000 + 48,000) = 287,500$

During the year, Pennell produced and sold 75,000 units of product at a sale price of \$6.50 per unit. What is the operating income (loss)?

Calculations: $(75,000 \times 6.50) - (113,000 + 39,000 + 48,000) - (165,000 + 52,000 + 24,000) = 46,500$

16) Canine Company produces and sells dog treats for discriminating pet owners. The unit selling price is \$10, unit variable costs are \$7, and total fixed costs are \$3,300. How many dog treats must Canine Company sell to breakeven?

Calculations: $(10 \times \text{treats}) - (7 \times \text{treats}) - \$3,300 = 0$

Treats = 1,100

The fourth learning objective is to use CVP methods to perform sensitivity analysis.

Managers often want to predict how changes in sales price, costs, or volume affect their profits. Managers can use CVP relationships to conduct sensitivity analysis. Sensitivity analysis is a “what-if” technique that asks what results are likely if selling price or costs change, or if an underlying assumption changes.

Using the components of the breakeven formula, managers can perform “what if” scenarios by changing selling price, variable costs, and fixed costs, and determine the impact on the breakeven point. The lower the breakeven point, the sooner the company begins earning a profit.

This table summarizes the effect of changes in selling price, variable costs per unit, and fixed costs on both the contribution margin and breakeven point. Notice the inverse relationship between contribution margin and breakeven point on the first four lines of the table.

Cause	Effect	Result
Change	Contribution margin	Breakeven point
Selling price increases	Increase	Decrease
Selling price decreases	Decrease	Increase
Variable cost per unit increases	Decrease	Increase
Variable cost per unit decreases	Increase	Decrease
Fixed costs increase	No effect	Increase
Fixed costs decrease	No effect	Decrease

Margin of safety

The margin of safety is the excess of expected sales over breakeven sales. The margin of safety is, therefore, the “cushion” or drop in sales that the company can absorb without incurring a loss.

Managers use the margin of safety to evaluate the risk of both their current operations and their plans for the future.



17) Fairfield Company management has budgeted the following amounts for its next fiscal year:

Total fixed expenses	
Sale price per unit	\$40
Variable expenses per unit	\$25

What will happen to the breakeven point in units if Fairfield can reduce fixed expenses by \$22,500?

$$\text{Breakeven Point} = \frac{\text{Fixed cost}}{\text{Contribution margin}}$$

$$\text{Breakeven Point} = \frac{\$832,500}{40 - 25} = 55500 \text{ units}$$

If the fixed expenses reduced by \$22,500 \Rightarrow fixed cost = \$810,000

$$\text{Breakeven Point} = \frac{\$810,000}{40 - 25} = 54000 \text{ units}$$

difference is 1,500 less

If Fairfield Company spends an additional \$30,000 on advertising, sales volume should increase by 2,500 units. What effect will this decision have on operating income?

$$[2500 \times (40 - 25)] - 30,000 = \$7,500$$

If Fairfield Company can reduce fixed expenses by \$41,625, by how much can variable expenses per unit increase and still allow the company to maintain the original breakeven point in units?

$$\text{Breakeven Point} = \frac{\$832,500}{40 - 25} = 55500 \text{ units}$$

$$(55500 \times 40) - \text{fixed cost } 790,875 = 1,429,125$$

$$\$1,429,125 / 55,500 = \$25.75, \text{ which is } \$0.75 \text{ more}$$

If fixed expenses increase by 10%, to maintain the original breakeven sales in units, the sale price per unit would have to be:

$$\text{Fixed cost} = \$832,500 \times 1.1 = 915,750;$$

$$\text{Total cost} = \begin{array}{l} \text{fixed cost} \\ \$915,750 \end{array} + \begin{array}{l} \text{variable cost} \\ (55500 \times 25) = 1,387,500 \end{array} = \$2,303,250$$

$$\$2,303,250 / 55,500 = 41.50;$$

$$(41.5 - 40) / 40 = 3.75\%$$

18) Lightfoot Company sells its product for \$55 and has variable costs of \$30 per unit. Total fixed costs are \$25,000. What will be the effect on the breakeven point if variable costs increase by 10% due to an increase in the cost of direct materials?

$$\text{Breakeven Point} = \frac{\text{Fixed cost}}{\text{Contribution margin}}$$

$$\text{Original Breakeven Point} = \frac{\$25,000}{55 - 30} = 1,000 \text{ units}$$

Variable costs increase by 10% $\Rightarrow (30 \times 1.10) = 33$

$$\text{Breakeven Point} = \frac{\$25,000}{55 - 33} = 1,136 \text{ units}$$

an increase of 136 units

19) Dakota Company provides the following information about its single product:

Targeted operating income	\$40,000
Selling price per unit	\$3.50
Variable cost per unit	\$1.05
Total fixed costs	\$90,000

How many units must be sold to earn the targeted operating income?

$$\text{Units to earn targeted operating income} = \frac{\text{Fixed cost} + \text{target income}}{\text{Contribution margin}}$$

$$= \frac{\$90,000 + 40,000}{3.50 - 1.05} = 53,061 \text{ units}$$

20) Given breakeven sales in units of 45,700 and a unit contribution margin of \$6, how many units must be sold to reach a target operating income of \$25,200?

$$25,200 / 6 = 4,200 \text{ units}$$

$$\text{breakeven sales in units } 45,700 + 4,200 = 49,900 \text{ units}$$

21) If the sales price per unit is \$75, variable expenses per unit are \$40, target operating income is \$22,000, and total fixed expenses are \$16,500, how many units must be sold to reach the target operating income?

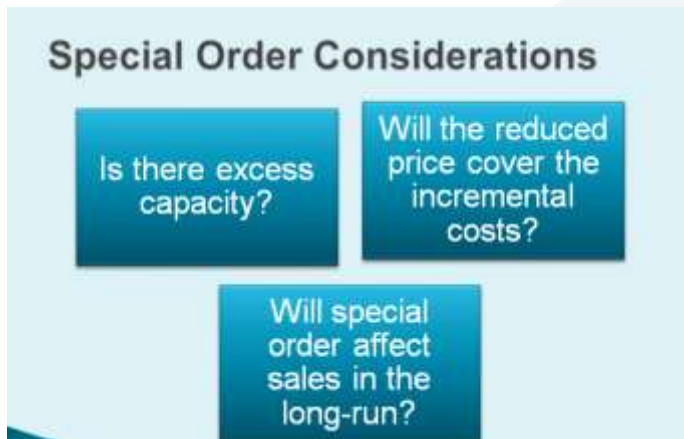
$$(75 \times \text{units}) - (40 \times \text{units}) - \$16,500 = \$22,000$$

$$\text{Units must be sold to reach the target operating income} = 1,100$$

Short-Term Business Decisions

Make special order and pricing decisions

A special order occurs when a customer requests a one-time order at a reduced sale price. Before agreeing to the special deal, management must consider the questions shown here.



First, managers must consider available capacity. If the company is already making as many units as possible with its existing manufacturing capacity and selling them all at its regular sales price, it would not make sense to fill a special order at a reduced sales price.

Therefore, available excess capacity that is not being used is almost a necessity for accepting a special order. This is true for service firms (law firms, hair salons, and so forth) as well as manufacturers.

Second, managers need to consider whether the special reduced sales price is high enough to cover the incremental costs of filling the order. The special price must exceed the variable costs of filling the order or the company will lose money on the deal. In other words, the special order must provide a positive contribution margin.

Next, the company must consider fixed costs. If the company has excess capacity, fixed costs probably will not be affected by producing more units (or delivering more service). However, in some cases, management may have to incur some other fixed cost to fill the special order—for example, additional insurance premiums. If so, they will need to consider whether the special sales price is high enough to generate a positive contribution margin and cover the additional fixed costs.

Finally, managers need to consider whether the special order will affect regular sales in the long run. Will regular customers find out about the special order and demand a lower price or take their business elsewhere? Will the special order customer come back again and again, asking for the same reduced price? Will the special order price start a price war with competitors? Managers should determine the answers to these questions and/or consider how customers will respond. Managers may decide that any profit from the special sales order is not worth these risks.

Lowwater Sailmakers manufactures sails for sailboats. The company has the capacity to produce 25,000 sails per year, and is currently producing and selling 20,000 sails per year. The following information relates to current production:

Sale price per unit	\$150
Variable costs per unit:	
Manufacturing	\$55
Marketing and administrative	\$25
Total fixed costs:	
Manufacturing	\$640,000
Marketing and administrative	\$280,000

1) If a special sales order is accepted for 5,000 sails at a price of \$125 per unit, and fixed costs remain unchanged, what is the change in operating income?

Operating income increases \$225,000

$$(\$125 \times 5,000) - (\$80 \times 5,000) = \$225,000$$

2) If a special sales order is accepted for 3,000 sails at a price of \$75 per unit, fixed costs remain unchanged, and there are no additional variable marketing and administrative costs for this order, what is the change in operating income?

Operating income increases \$60,000

Increase in operating income = cm/u of this order x #units ordered =

$$(\$75 - \$55) \times 3000 \text{ u} = \$60,000$$

3) If a special sales order is accepted for 2,000 sails at a price of \$95 per unit, and fixed costs increase by \$10,000, what is the change in operating income affected?

Operating income increases \$20,000.

$$\text{Incremental CM} = 2000(\$95 - \$80) = \$30,000 \text{ less incremental FC of } \$10,000 = \$20,000$$

4) If a special sales order is accepted for 2,500 sails at a price of \$70 per unit, fixed costs increase by \$10,000, and variable marketing and administrative costs for that order decrease by \$5 per unit, how what is the change in operating income?

Operating income decreases \$22,500.

Change in operating income = (SP/u - VC/u) x #units ordered - increase in FC =

$$(\$70 - \$75) \times 2500 \text{ units} - \$10,000 = (\$12,500) - \$10,000 = (\$2,500)$$