Lecture Notes – Chapter 18: COST BEHAVIOR AND COST-VOLUME-PROFIT ANALYSIS

IDENTIFYING COST BEHAVIOR

Background
Managerial accountants play a large role in planning a company's future activities. This involves forecasting future revenue volume, the costs expected with that revenue volume, and profits.

Why is this important?
A very important tool to help management forecast costs and profits is called cost-volume-profit (CVP) analysis. CVP starts with computing the break-even point. The break-even point is the sales level at which costs are equal to sales and no profit or loss is earned.

CVP is a very powerful tool, and can be used to answer questions such as:
- What sales volume is needed to break-even for a new business?
- What sales volume is required to earn a target profit?
- How would the break-even point change is a company acquires new machinery?
- How would the break-even point change if additional employees are hired, or existing employees terminated?

Identifying cost behavior
The first step in learning CVP is to understand how costs change when the volume of activity, such as units produced, changes. Costs may be classified as either fixed, variable, mixed, or step-wise.

Fixed costs:
The total amount of fixed costs remains unchanged when volume changes, within a relevant range of operations. The relevant range of operations is the normal operating range for a business, with existing machinery.

On a per unit basis, as the level of production changes the fixed cost *per unit* of output decreases as volume increases (and vice versa).

When production volume and costs are graphed, units of product are usually plotted on the *horizontal* axis and dollars of cost are plotted on the *vertical* axis.

        a. Fixed costs are represented by a horizontal line with no slope.
        b. The horizontal line starts on the vertical axis at the fixed cost amount.

Examples of fixed costs are factory rent, depreciation (straight-line method), and supervisors' salaries.

Variable costs:
A variable cost increases or decreases as volume of activity increases or decreases.

On a per unit basis, a variable cost *per unit* remains constant but the *total* amount of variable cost changes with the level of production.

When production volume and variable costs are graphed,

      a. Variable cost is represented by a straight line starting at the zero cost level.
      b. The straight line is upward (positive) sloping. The line rises as volume increases.

Examples of variable costs include direct materials costs and sales commissions.

Mixed costs:
Mixed costs include both fixed and variable cost components.

When volume and mixed costs are graphed, mixed costs are represented by a straight line with an upward (positive) slope. The line starts at the fixed cost point on the vertical axis. As activity level increases, the mixed cost line increases at an amount equal to the variable cost per unit.

One example of a mixed cost is a telephone bill: there is a flat charge (fixed cost), even if no calls are made, but the total telephone expense increases as calls (variable costs) are made. Additionally, a salesperson compensated with a fixed monthly salary plus commissions on sales is a mixed cost.

Step-wise costs:
Step-wise costs are fixed within the relevant range of activity. If production volume expands significantly, total costs go up by a lump-sum amount (stair-step cost). An example is a factory expansion; with additional equipment and supervisors, fixed costs change.

Step-wise costs are treated as either fixed or variable cost in conventional CVP analysis depending on the width of the relevant range of activity.

Curvilinear Costs:
Curvilinear costs increase at a non-constant rate as volume increases.

When volume and costs are graphed, curvilinear costs appear as a curved line that starts at the graph origin (total cost is zero when volume is zero) and increases at different rates.

<u>Measuring cost behavior</u>

CVP requires all costs be characterized as either fixed or variable. This means we must analyze mixed costs to determine their fixed and variable components. There are three methods commonly used to analyze these costs: scatter diagrams, the high-low method, and regression analysis (least-squares regression).

Scatter diagrams:

The scatter diagram displays data about past costs and units in graphical form. The unit volume is plotted on horizontal axis, and the costs on the vertical axis. Each point reflects the cost and volume levels for a prior period. The estimated line of cost behavior is drawn by fitting a line that best "fits" the points visually. The following summarizes the results from drawing a scatter diagram:

      a. Intersection point of line on cost axis is at fixed cost amount.
      b. The variable cost per unit of volume equals the slope of the line.
         i. Select any two points on horizontal axis.
        ii. Draw a vertical line from each of these points to intersect the estimated line of cost behavior.
        iii. Compute the slope of the line, or variable cost, as the change in cost divided by the change in sales.
      c. Cost equation.
        i. Total Costs = Fixed costs plus (variable cost per unit times number of units of volume).
        ii. Useful to predict future cost levels at different volumes.

A deficiency of the scatter diagram method is that estimates are based on "visual fit" of cost line, subject to interpretation.

High-low method:

The high-low method uses a two-step process to calculate variable and fixed costs. The formula to calculate variable cost per unit is:

Variable cost per unit = (Highest cost – lowest cost) / (Highest unit production – lowest unit production)

Once the variable cost per unit is known, the fixed costs are calculated. Pick either the high-cost point or low-cost point. Then, use the following formula:

Total costs = Fixed costs + Variable costs (# units * variable cost/unit)

The fixed costs are solved algebraically.

A deficiency of the high-low method is that it ignores all points except the highest and lowest, resulting in less precision.

Here is a guided example illustrating both the scatter diagram and high-low methods:
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Least-squares regression:

Least-Squares Regression is a statistical method of identifying cost behavior. Computation details are covered in advanced cost accounting courses. It is the most precise of the three methods discussed, as it uses all data points available.

USING BREAK-EVEN ANALYSIS

Break-even analysis requires knowing several basic formulas. A summary of these formulas follow.

Name	*Formula*
Contribution margin per unit	Sales price per unit – variable costs per unit
Contribution margin ratio	Contribution margin per unit / sales price per unit
Break-even point, in units	Fixed costs / Contribution margin per unit
Break-even point, in dollars	Fixed costs / Contribution margin ratio
Number of units needed to earn a target profit	(Fixed costs + Target Profit) / Contribution margin per unit
Number of sales dollars needed to earn a target profit	(Fixed costs + Target Profit) / Contribution margin ratio
Margin of safety, in dollars	Expected sales – Break-even sales
Margin of safety, in percent	(Expected sales – Break-even sales) / Expected sales

The following are several guided examples using the above formulas.

Contribution margin and contribution margin ratio:
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Contribution margin and calculating the break-even point:
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Computing sales required to achieve target profit:
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Computing margin of safety:
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Calculating break-even point in sales and units using an income statement:
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Multi-product break-even point

Most companies sell more than one product. The proportion of the sales for each product is called the sales mix. Applying CVP to a multi-product environment requires using a "composite unit" approach. This approach is summarized as follows.

      a. Determine sales mix of various products.
      b. Using sales mix, determine the selling price of a composite unit by multiplying the sales mix ratio times the selling price of each product and then adding the totals for all of the products.
      c. Compute the variable price of a composite unit in the same manner, and then determine the CM per composite unit.
      d. Break-even point in composite units equals total fixed costs divided by CM per composite unit.
      e. To determine how many units of each product must be sold to break even, multiply the number of units of each product in the composite unit by the break-even point in composite units.

A guided example of multi-product break-even calculations follows.

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Decision Analysis--Degree of Operating Leverage

Operating leverage is a useful tool in assessing the effect of changes in the level of sales on income.
      A. Operating leverage is the extent, or relative size, of fixed costs in the total cost structure.
      B. Degree of operating leverage (DOL) is defined as total CM (in dollars) divided by pretax income.
      C. Use DOL to measure the effect of changes in the level of sales on pretax income by multiplying DOL by the percentage change in sales.

A guided example using degree of operating leverage follows.
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