

CHAPTER 2

COST BEHAVIOUR

Chapter 2 provides the basics of cost behaviour, focusing on expanded definitions of fixed and variable costs and introducing the concept of mixed costs. Methods of separating mixed costs into fixed and variable elements are presented and discussed. In addition, the resource usage model is presented. This chapter is an important foundation for Chapter 3, Cost-Volume-Profit Analysis.

LEARNING OBJECTIVES

After studying Chapter 2, students should be able to:

1. Define and describe fixed, variable, and mixed costs.
2. Explain the use of resources and activities and their relationship to cost behaviour.
3. Separate mixed costs into their fixed and variable components using the high-low method, the scatterplot method, and the method of least squares.
4. Evaluate the reliability of the cost formula.
5. Discuss the use of managerial judgment in determining cost behaviour.
6. Explain how multiple regression can be used to assess cost behaviour.
7. Define the learning curve, and discuss its impact on cost behaviour.

KEY TOPICS

The following major topics are covered in this chapter (related learning objectives are listed for each Topic):

1. Basics of Cost Behaviour (LO 1)
2. Resources, Capacity, and Cost Behaviour (LO 2)
3. Quantitative Methods for Separating Mixed Costs (LO 3)
4. Reliability of Cost Formulas (LO 4)
5. Methods of Determining Cost Behaviour and Managerial Judgment (LO 5)

6. Multiple Regression (LO 6)

7. The Learning Curve and Nonlinear Cost Behaviour (LO 7)

I. BASICS OF COST BEHAVIOUR

Cost behaviour refers to whether a cost changes when the level of output changes. Usually costs are placed into one of four categories: fixed costs, variable costs, mixed costs, and step costs. These categories are reasonably accurate within a relevant range of activity.

Relevant range: The range of activity over which the assumed cost relationship is valid for the normal operations of a firm is called the relevant range. While the cost function may not be linear, we will often assume linearity because the function will appear to be linear within the relevant range.

Fixed costs: Fixed costs are costs that do not change in total as the activity level changes. All costs are considered to be fixed in the short run. The term “fixed cost” does not mean that the cost cannot change over time, but that a change in the activity level will not cause a change in the total cost. The duration of the short run can change depending on the cost under consideration. Total fixed costs can be described in equation format to be:

$$F = \text{Total fixed costs}$$

Teaching hint: Some students have a hard time with the concept of fixed cost because they equate it to “never changing.” However, their experience living in an inflationary economy is that costs do change (typically upward). Thus, they think that no cost can ever be fixed. The key point is that a fixed cost does not change because activity level changes; a fixed cost can change for other reasons. For example, a salaried supervisor could be given a raise during the year because of excellent performance or in an effort to keep him from taking a job with another firm. The increase in his salary would be a change in a fixed cost. The change was not, however, due to an increase in the level of activity.

Variable costs: Variable costs are costs that, in total, will vary in direct proportion to changes in activity level, which is commonly defined as some measure of production or sales activity (e.g., direct labour hours, units produced, or units sold). Activity level can refer to the level of any cost driver (e.g., setup time, number of material moves, etc.) in an activity-based costing system. Total variable costs can be described in equation format to be:

$$Y_v = VX$$

where

Y_v = Total variable costs

V = Variable cost per unit

X = Number of units of the driver

Exhibits 2-1 and 2-2 (pp. 48–49) present the graphical presentations of a fixed cost and a variable cost.

Teaching hint: You might emphasize that the total variable costs increases (decreases) as activity level increases (decreases). However, variable cost per unit stays constant as activity level changes. Students often have difficulty and confuse the two.

Mixed costs: Costs that have both a fixed and a variable component are classified as mixed costs. A salesperson paid a salary of \$20,000 plus a commission equal to 5 percent of sales is an example of a mixed cost.

Total mixed costs can be described as:

$$Y = F + VX$$

where

Y = Total cost

F , V , and X are defined previously in the chapter.

Cornerstone 2-1 (p. 51) shows how the linear equation can be used to describe a mixed cost. Exhibit 2-5 (p. 52) presents a graph of a mixed cost.

II. RESOURCES, CAPACITY, AND COST BEHAVIOUR

Resources are economic elements that permit one to perform activities. Common resources include direct materials, direct labour, equipment, etc. Resources can be categorized as either flexible or committed.

Flexible resources are supplied as used and needed (e.g., direct materials).

Committed resources are supplied in advance of usage. These resources are acquired by the use of either an explicit or implicit contract to obtain a given quantity of resource, regardless of whether the amount of the resource available is fully used or not. Committed resources may have unused capacity (e.g., buying or leasing a building or equipment).

Activities are tasks such as setting up equipment, purchasing materials, and assembling materials. *Activity capacity* is the ability to perform activities. When a company acquires resources necessary to perform an activity, it is obtaining activity capacity. *Practical capacity* is the efficient level of activity performance.

A *step-cost function* has the property of displaying a constant level of cost for a range of activity and then jumping to a higher level of cost at some point, where it remains for a similar range of activity. A step-cost function is illustrated in Exhibit 2-6 (p. 55).

A *step-variable cost* is simply a step-cost that changes for relatively narrow ranges of activity. This type of cost is usually treated as if it were a pure variable cost because of the narrow ranges of activity.

Step-costs that have relatively wide levels of activity are known as *step-fixed costs*. The difference between step-variable and step-fixed costs is the range of activity included at each step. For example, a step-variable cost may increase for every 100 units produced, while a step-fixed cost may increase for every 10,000 units produced. A step-fixed cost is usually treated as a fixed cost. Exhibit 2-7 (p. 55) displays a step-fixed cost.

A traditional cost management system typically provides information only about the cost of the resources supplied. A contemporary cost management system provides information about how much of the activity is used and the cost of its usage.

The relationship between resources supplied and resources used is expressed by either of the following equations:

$$\text{Activity availability} = \text{Activity used (output)} + \text{Unused capacity}$$

$$\text{Cost of available activity} = \text{Cost of activity used (output)} + \text{Cost of unused activity}$$

Cornerstone 2-2 (p. 56) illustrates the way a company may determine the cost of capacity used and unused capacity.

III. QUANTITATIVE METHODS FOR SEPARATING MIXED COSTS

To facilitate planning and decision making, managers need to know the fixed and variable components of mixed costs. The text presents three methods used to separate a mixed cost into its fixed and variable components: the high-low method, the scatterplot method, and the method of least squares.

A. The High-Low Method

When using the *high-low method*, the highest point and the lowest point are used for creating the cost formula. The high point is defined as the point with the *highest activity level* and the low point as the point with the *lowest activity level*. The *independent variable* should be used when selecting the highest and lowest activity levels. Always make sure that the high and low activity points are representative of the rest of the points. A scatterplot would be helpful to see whether the two points are representative of the others.

Letting (X_1, Y_1) be the low point and (X_2, Y_2) be the high point, the equations for determining the *slope parameter* and *intercept parameter* are, respectively:

$$\begin{aligned} V &= \text{Change in cost} / \text{Change in activity} \\ &= (Y_2 - Y_1) / (X_2 - X_1) \end{aligned}$$

$$F = \text{Total mixed cost} - \text{Variable cost}$$

$$= Y_2 - VX_2$$

or

$$F = Y_1 - VX_1$$

Cornerstone 2-3 (p. 59) shows how the high-low method can be used to determine the fixed cost and variable rate.

Teaching hint: Tell the students that the high-low method is nothing more than finding the equation of a line through two points.

B. Scatterplot Method

Using the *scatterplot method*, the manager plots the observations of cost and activity level on a graph. The manager selects two points by visual inspection of the *scattergraph* and fits a line to these two points. This is accomplished by using the slope-intercept method from basic algebra. The slope is the change in cost divided by the change in activity. Once the slope is known, simply substitute the slope and the values of one of the two points into the linear cost formula ($Y = F + VX$) and solve for the fixed component, F ($F = Y - VX$).

Exhibit 2-8 (p. 61) presents a plot of data points, along with the graph of a line for the high-low method and a possible scattergraph line.

C. The Method of Least Squares

The *method of least squares* identifies the line that best fits the data points (the sum of the squared *deviations* is minimized). This method is the most sophisticated and provides the user with a measure of the goodness of fit, which can be used to assess the usefulness of the cost formula. If the fit is not very good, then a search for additional activity variables may be needed.

D. Using Regression Programs

Computing the regression formula manually is tedious and best left to a statistics course. The same program can be used for multiple regression as well. Cornerstone 2-4 (p. 64) displays how to take the results of the regression program and to use them to construct a cost formula. That cost formula can then be used to determine the predicted cost given an estimate of the independent variable.

IV. RELIABILITY OF COST FORMULAS

There are two basic measures for determining the reliability of cost formulas: coefficient of determination and coefficient of correlation.

The *coefficient of determination* (R^2) is a measure of the *goodness of fit*. It shows the percent of the variation in the dependent variable that is explained by the independent variable (or variables). The higher the percentage of variability explained, the better the fit.

The *coefficient of correlation* (r) is the square root of the coefficient of determination. If the coefficient of correlation is positive, the independent variable and the dependent variable move together in the same direction. If it is negative, the independent variable and the dependent variable move in a predictable fashion in opposite directions.

V. METHODS OF DETERMINING COST BEHAVIOUR AND MANAGERIAL JUDGMENT

Activities may use a mix of resources acquired in advance and resources that are acquired as needed. As a result they display mixed cost behaviour. In practice, companies use a variety of methods of estimating cost, and a variety of quantitative and statistical methods.

The *industrial engineering method* is a forward-looking method of determining, through physical observation and analysis, just what activities, in what amounts, are needed to complete a process.

The *account analysis method* is used to estimate costs by classifying accounts in the general ledger as fixed, variable, or mixed. To use the account analysis method, the accountant uses judgment and experience to separate the accounts into two categories—fixed and variable. Once the fixed categories are known, the average monthly cost can be computed, and this is the fixed amount. The variable categories need to be further separated into categories according to the driver the accountant wishes to associate with the account. Cornerstone 2-5 (p. 68) shows how the account analysis method can be used to separate fixed and variable costs, determine a cost function, and use that cost function in budgeting.

Managerial Judgment

Managerial judgment is a simple approach to classifying costs as variable or fixed. When managers have a thorough understanding of the firm and its cost patterns, this method can give good results. If the manager has poor judgment, errors will occur. With regard to using judgment, the manager may want to: (1) consider past experience, (2) confirm results with operating personnel, and (3) use common sense to confirm statistical studies.

VI. MULTIPLE REGRESSION

Multiple regression can be used to predict a cost function when there is more than one independent variable. When using a spreadsheet to perform regression analysis, multiple regression is no more difficult than simple regression that assists us to construct a cost equation.

VII. THE LEARNING CURVE AND NONLINEAR COST BEHAVIOUR

The *learning curve* shows how the labour hours worked per unit decrease as the volume produced increases. The use of the learning curve enables management to be more accurate in budgeting and in performance evaluations for processes in which learning occurs. In order to use a learning curve model, management must estimate a learning rate for a process, usually on the basis of past experience. The learning curve model takes two common forms: (1) the cumulative average-time learning curve model, and (2) the incremental unit-time learning curve model.

The *cumulative average-time learning curve model* assumes that the cumulative average time per unit decreases by a constant percentage, or *learning rate*, each time the cumulative quantity of units produced doubles. Cornerstone 2-6 (p. 72) shows how to calculate the amount of time needed for producing successive units given the learning rate and direct labour hours for the first unit. Then, Exhibit 2-10 (p. 74) displays an Excel screenshot of the results for the cumulative average-time learning model. Exhibit 2-11 (p. 74) shows the graph of both the cumulative average time per unit (the bottom line) and the cumulative total hour's required (top line).

The *incremental unit-time learning curve model* assumes that the time necessary for production decreases by a constant percentage each time the cumulative quantity of units produced doubles.

INFORMATION ABOUT EXERCISES, PROBLEMS, AND CASES

Exercises and problems are described on the following two pages according to coverage of content, learning objective(s), and level of difficulty. The time required to solve the problems is roughly proportional to the level of difficulty.

In general, *basic* exercises/problems are fairly simple and straightforward. The text material is relatively brief; only one or two concepts are covered. Basic exercises and problems should take about 15 to 20 minutes each.

Moderate exercises/problems may take longer and involve more concepts. These problems may have a “twist” and require more thought. Moderate exercises and problems may take 20 to 40 minutes each.

Challenging problems are more comprehensive and may cover more concepts. The text material is relatively longer and may include some ambiguity. Challenging problems may take 60 to 90 minutes each.

**Cornerstone
Exercise
(CS)/**

Exercise/ Problem	Topic	Learning Objective	Degree of Difficulty
CS 2-1	Mixed Costs and Cost Formula	LO 1	Basic
CS 2-2	Activity Availability, Capacity Used, Unused Capacity	LO 2	Basic
CS 2-3	High-Low Method to Determine Fixed Cost and Variable Rate	LO 3	Basic
CS 2-4	Using Regression Results to Construct and Apply a Cost Formula	LO 3	Basic
CS 2-5	Account Analysis to Determine Cost Behaviour	LO 5	Basic
CS 2-6	Using Multiple Regression Results to Construct and Apply a Cost Formula	LO 6	Basic
CS 2-7	Cumulative Average-Time Learning Curve	LO 7	Basic
2-8	Variable, Fixed, and Mixed Costs	LO 1	Basic
2-9	Cost Behaviour	LO 1	Basic
2-10	Types of Costs	LO 1	Basic
2-11	Resource Usage Model and Cost Behaviour	LO 2	Basic
2-12	Resource Usage and Supply, Activity Rates, Service Organization	LO 2	Basic
2-13	Step Costs, Relevant Range	LO 1, 2	Basic
2-14	Account Analysis Method	LO 5	Basic
2-15	Account Analysis Method	LO 5	Basic
2-16	Scattergraph Method, High-Low Method	LO 3	Basic
2-17	Method of Least Squares, Goodness of Fit	LO 3, 4	Moderate
2-18	High-Low Method, Cost Formulas	LO 3	Moderate
2-19	Method of Least Squares, Evaluation of Cost Equation	LO 3, 4	Moderate
2-20	Multiple Regression	LO 6	Moderate
2-21	Multiple Regression	LO 6	Moderate
2-22	Learning Curve	LO 7	Moderate
2-23	Learning Curve	LO 7	Moderate
2-24	Cost Behaviour Patterns	LO 1, 2	Moderate
2-25	Cost Behaviour, Resource Usage, Excess Capacity	LO 1, 2	Moderate
2-26	Cost Behaviour, High-Low Method, Pricing Decision	LO 1, 3	Moderate
2-27	High-Low Method, Method of Least Squares, Correlation	LO 2, 3, 4	Moderate
2-28	Cost Formulas, Single and Multiple Activity Drivers, Coefficient of Correlation	LO 1, 3, 4, 6	Moderate
2-29	Scatterplot, High-Low Method, Regression	LO 3, 4, 6	Moderate
2-30	Method of Least Squares	LO 1, 3, 4, 6	Moderate
2-31	High-Low Method, Scatterplot, Regression	LO 2, 3, 4, 6	Moderate
2-32	Comparison of Regression Equations	LO 1, 3, 4, 6	Challenging

**Cornerstone
Exercise
(CS)/**

Exercise/ Problem	Topic	Learning Objective	Degree of Difficulty
2-33	Multiple Regression, Confidence Intervals, Reliability of Cost Formulas	LO 2, 4, 6	Challenging
2-34	Learning Curve	LO 7	Moderate
2-35	Learning Curve	LO 7	Moderate
CMA 2-1	Simple and Multiple Regression, Evaluating Reliability of an Equation	LO 2, 3, 4	Challenging

LIST OF ILLUSTRATIONS

Illustration	Topic
Exhibit 2-1	Fixed Cost Behaviour
Exhibit 2-2	Variable Cost Behaviour
Exhibit 2-3	Nonlinearity of Variable Costs
Exhibit 2-4	Relevant Range for Variable Costs
Exhibit 2-5	Mixed Cost Behaviour
Exhibit 2-6	Step-Cost Function
Exhibit 2-7	Step-Fixed Costs
Exhibit 2-8	Scattergraph for Anderson Company's Materials Handling Costs
Exhibit 2-9	Deviations of Data from a Line
Exhibit 2-10	Spreadsheet for Cumulative Average-Time Learning Model
Exhibit 2-11	Graph of Cumulative Total Hours Required and the Cumulative Average Time per Unit