Chapter 10:
Determining How Costs Behave

Horngren 13e

The Linear Cost Function

$$y = a + bX$$

- y — The Dependent Variable: The cost that is being predicted
- a — The Intercept: Fixed Costs
- b — The slope of the line: variable cost per unit
- X — The Independent Variable: The cost driver

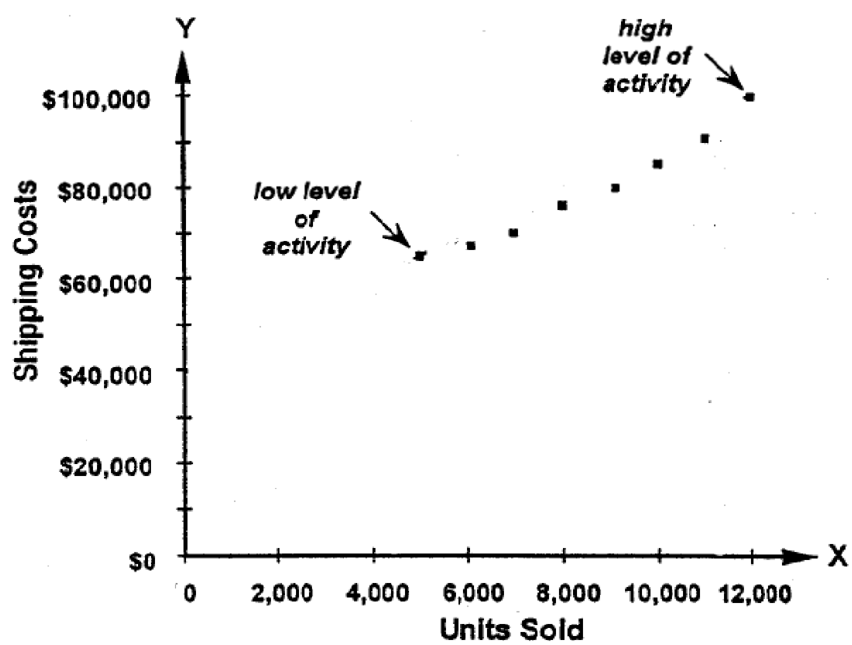
ANALYSIS OF MIXED COSTS: HIGH-LOW METHOD

EXAMPLE: Kohlson Company has incurred the following shipping costs over the past eight months:

	Units Sold	*Shipping Cost*
January...	**6,000**	**$66,000**
February.	**5,000**	**$65,000**
March	**7,000**	**$70,000**
April........	**9,000**	**$80,000**
May.........	**8,000**	**$76,000**
June........	**10,000**	**$85,000**
July.........	**12,000**	**$100,000**
August....	**11,000**	**$87,000**

With the high-low method, only the periods in which the lowest activity and the highest activity occurred are used to estimate the variable and fixed components of the mixed cost.

EVALUATION OF THE HIGH-LOW METHOD

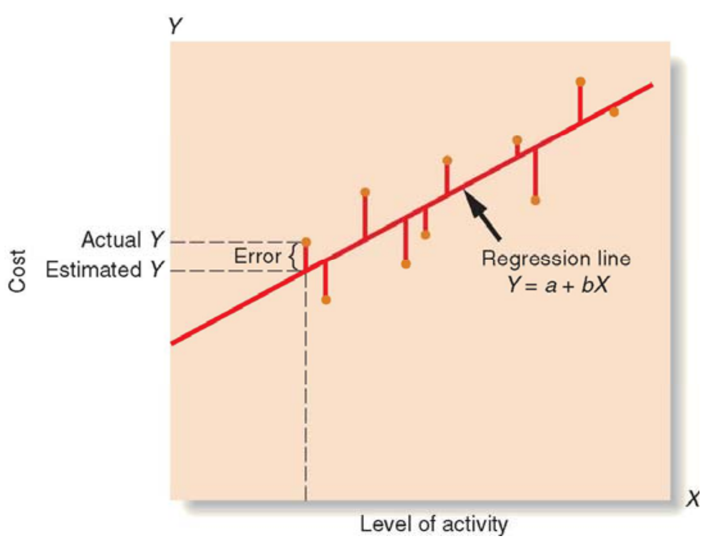


Regression Analysis

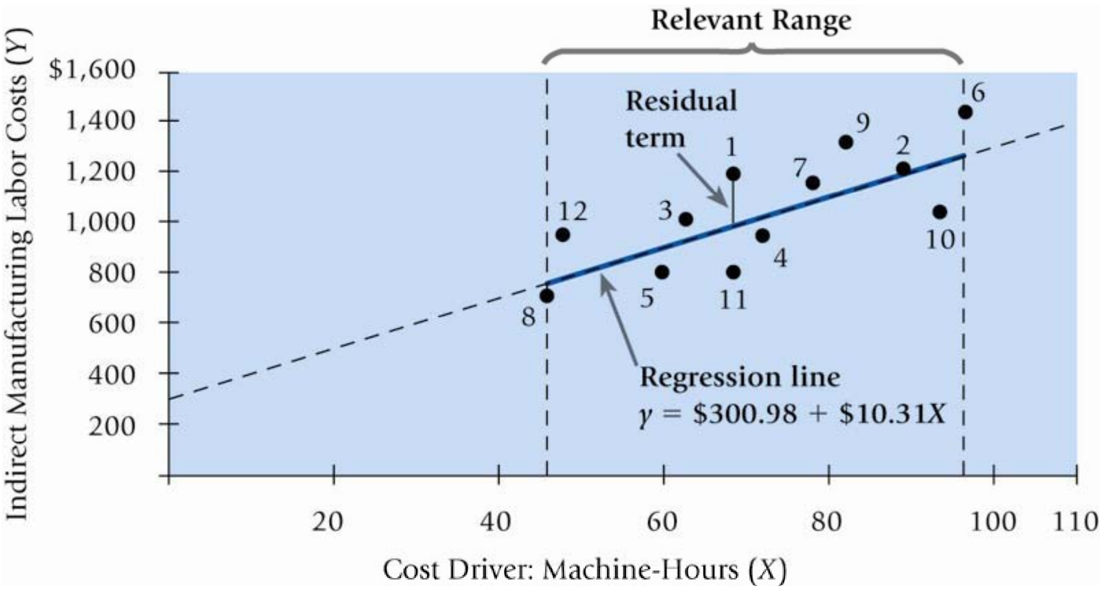
- Regression analysis is a statistical method that measures the average amount of change in the dependent variable associated with a unit change in one or more independent variables
- Is more accurate than the High-Low method because the regression equation estimates costs using information from *all* observations; the High-Low method uses only *two* observations

LEAST-SQUARES REGRESSION METHOD

The least-squares regression method for analyzing mixed costs uses mathematical formulas to determine the regression line that minimizes the sum of the squared "errors."



Sample Regression Model Plot



Learning Objective 1: Explain the two assumptions frequently used in cost-behavior estimation . . . cost functions are linear and have a single cost driver

Write a linear cost function equation for each of the following conditions. Use y for estimated costs and X for activity of the cost driver.

a. Direct manufacturing labor is $10 per hour.
b. Direct materials cost $9.20 per cubic yard.
c. Utilities have a minimum charge of $1,000, plus a charge of $0.05 per kilowatt-hour.
d. Machine operating costs include $200,000 of machine depreciation per year, plus $75 of utility costs for each day the machinery is in operation.

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Answer:

a. y = $10X
b. y = $9.20X
c. y = $1,000 + $0.05X
d. y = $200,000 + $75X

Learning Objective 4: Estimate a cost function using quantitative analysis . . . the end result is to evaluate the cost driver of the estimated cost function

The managers of the production department have decided to use the production levels of 20X2 and 20X4 as examples of the highest and lowest years of operating levels. Data for those years are as follows:

Year	Chemicals used	Overhead Costs
20X2	140,000 gallons	$115,000
20X4	120,000 gallons	$100,000

Required:

What is the cost estimating equation for the department if gallons of chemicals are used as the cost driver?

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Answer:

Slope (variable cost) = ($115,000 - $100,000) / (140,000 - 120,000) =$0.75

Constant (fixed cost) = $100,000 - $0.75(120,000) = $10,000

Estimating equation = $10,000 + $0.75DM

Learning Objective 4: Estimate a cost function using quantitative analysis . . . the end result is to evaluate the cost driver of the estimated cost function

The Wildcat Company has provided the following information:

Units of Output	30,000 Units	42,000 Units
Direct materials	$ 180,000	$ 252,000
Workers' wages	1,080,000	1,512,000
Supervisors' salaries	312,000	312,000
Equipment depreciation	151,200	151,200
Maintenance	81,600	110,400
Utilities	384,000	528,000
Total	$2,188,800	$2,865,600

Using the high-low method and the information provided above,
a. identify the linear cost function equation and
b. estimate the total cost at 36,000 units of output.

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a. identify the linear cost function equation and
b. estimate the total cost at 36,000 units of output.

Answer:

a. Variable cost = ($2,865,600 - $2,188,800) / (42,000 - 30,000) = $56.40
Fixed cost = $2,865,600 - $56.40 × 42,000 = $496,800

Cost function is y = $496,800 + $56.40X

b. Output level of 36,000 units = $496,800 + $56.40 × 36,000 = $2,527,200 total cost

Learning Objective 4: Estimate a cost function using quantitative analysis . . . the end result is to evaluate the cost driver of the estimated cost function

Tessmer Manufacturing Company produces inventory in a highly automated assembly plant in Olathe, Kansas. The automated system is in its first year of operation and management is still unsure of the best way to estimate the overhead costs of operations for budgetary purposes. For the first six months of operations, the following data were collected:

	Machine-hours	Kilowatt-hours	Total Overhead Costs
January	3,800	4,520,000	$138,000
February	3,650	4,340,000	136,800
March	3,900	4,500,000	139,200
April	3,300	4,290,000	136,800
May	3,250	4,200,000	126,000
June	3,100	4,120,000	120,000

Required:

a. Use the high-low method to determine the estimating cost function with machine-hours as the cost driver.
b. Use the high-low method to determine the estimating cost function with kilowatt-hours as the cost driver.
c. For July, the company ran the machines for 3,000 hours and used 4,000,000 kilowatt-hours of power. The overhead costs totaled $114,000. Which cost driver was the best predictor for July?

Answer:

a. Machine-hours:
Slope coefficient = ($139,200 - $120,000) / (3,900 - 3,100)
= $24.00 per machine-hour
Constant = $139,200 - ($24 × 3,900) = $45,600
Machine-hour estimating equation = $45,600 + $24X

b. Kilowatt-hours:
Slope coefficient = ($138,000 - $120,000) / (4,520,000 - 4,120,000)
= $0.045 per kilowatt-hour
Constant = $138,000 - ($0.045 × 4,520,000) = -$65,400
Kilowatt-hour estimating equation = -$65,400 + $0.045KWH

c. July's estimated costs:
with machine-hours = $45,600 + $24 × 3,000 = $117,600
with kilowatt-hours = -$65,400 + $0.045 × 4,000,000 = $114,600
The best estimator for July was the kilowatt-hour cost driver.

Least-Squares Regression & Statistical Analysis

The new cost analyst in your accounting department has just received a computer-generated report that contains the results of a simple regression program for cost estimation. The summary results of the report appear as follows:

Variable	Coefficient	Standard Error	t-Value
Constant	$35.92	$16.02	2.24
Independent variable	$563.80	$205.40	2.74

R^2 = 0.75

Required:

a. What is the cost estimation equation according to the report?

b. What is the goodness of fit? What does it tell about the estimating equation?

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Answer:

a. y = $35.92 + $563.80X

b. Goodness of fit is 0.75. It measures how well the predicted values match the actual observations. In this case, the equation passes the goodness of fit test because it is substantially above 0.30, the threshold of acceptance.

Least-Squares Regression & Statistical Analysis

Newton Company used least squares regression analysis to obtain the following output:

	Payroll Dept Cost Explained by # of Employees
Constant	$5,800
Standard error of Y estimate	630
R^2	0.8924
Number of observations	20
X coefficient(s)	$1.902
Standard error of coefficient(s)	0.0966

Required:

a. What is the total fixed cost?

b. What is the variable cost per employee?

c. Prepare the linear cost function.

d. What is the coefficient of determination? Comment on the goodness of fit.

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Answer:

a. The constant or intercept is the total fixed cost of $5,800.

b. The variable cost per employee is the X coefficient of $1.902.

c. y = $5,800 + $1.902X

d. The coefficient of determination is the R^2 of 0.8924. This represents a very high goodness of fit. The closer to 1.0, the better the cost driver explains the cost. Therefore, the conclusion can be drawn that there is a significant relationship between the cost of the payroll department and the number of employees.

Least-Squares Regression & Statistical Analysis

Schotte Manufacturing Company uses two different independent variables (machine-hours and number of packages) in two different equations to evaluate costs of the packaging department. The most recent results of the two regressions are as follows:

Machine-hours:

Variable	Coefficient	Standard Error	t-Value
Constant	$748.30	$341.20	2.19
Independent Variable	$52.90	$35.20	1.50

$R^2 = 0.33$

Number of packages:

Variable	Coefficient	Standard Error	t-Value
Constant	$242.90	$75.04	3.24
Independent Variable	$5.60	$2.00	2.80

$R^2 = 0.73$

Required:

a. What are the estimating equations for each cost driver?

b. Which cost driver is best and why?

Least-Squares Regression & Statistical Analysis

Answer:

a. Machine-hours y = $748.30 + $52.90X
Number of packages y = $242.90 + $5.60X

b. Machine-hours has a low R^2 which implies that a small proportion of the variance is explained by machine-hours, thereby making it less attractive than number of packages as a cost predictor.

Also, for the independent variable, number of packages, the t-value of 2.80 indicates that a relationship exists between the independent and dependent variables. For machine-hours, the t-value (1.50) is below 2.00, indicating that the coefficient is not significantly different from zero and that there may not be a relationship between the independent and dependent variables.

The t-values of the constant terms (g) for both drivers is greater than 2.00, therefore, there is no distinguishing characteristic between the constants.

Given the above findings, it appears that number of packages is the best predictor of costs of the packing department.