



Cost Behavior with Regression Analysis

BS accountancy (University of Cebu)

MAS-02: COST BEHAVIOR WITH REGRESSION ANALYSIS

COST BEHAVIOR

Cost behavior analysis deals with understanding how costs change in response to changes in an activity like production or sales. Management typically performs cost behavior analysis through mathematical cost functions.

$$\text{The Cost Function: } Y = a + bX$$

[Y] - total costs (dependent variable)
[a] - total fixed costs (Y-axis intercept)
[bX] - the total variable costs

[X] - activity or cost driver (independent variable)
[b] - variable cost per unit (slope of the line)

As certain activity increases, some costs remain constant or the same while some costs will vary or change. Consider the following cost behavior patterns (assume activity is based on production):

	TOTAL COST	PER-UNIT COST
FIXED	Constant (<i>"a" in cost function</i>)	Decreases as production increases (indicating <i>INVERSE</i> relationship)
VARIABLE	Increases as production increases (indicating <i>DIRECT</i> relationship)	Constant (<i>"b" in cost function</i>)
MIXED (semi-variable)	Increases less proportionately vs. total variable costs as production increases	Decreases less proportionately vs. unit fixed costs as production increases

LIMITATIONS of COST BEHAVIOR ANALYSIS

- RELEVANT RANGE** assumption
Relevant range refers to the range of activity within which the cost behavior patterns are valid and cost relationships are linear. Beyond the range, the cost may show a different cost behavior pattern.
- TIME PERIOD** assumption
The cost behavior patterns identified are valid only over a specific period of time. Beyond the period, the cost may show a different cost behavior pattern.

COST ESTIMATION: SEGREGATING VARIABLE & FIXED COSTS

1) HIGH-LOW POINTS method

The fixed and variable portions of the mixed costs are computed from the highest and lowest points based on activity or cost driver.

$$\text{Variable cost per unit (b)} = \frac{\text{Change in Costs (Y}_H - Y_L)}{\text{Change in Activity (X}_H - X_L)}$$

2) GRAPHIC method (Scatter Diagram/Scatter Graph/Scatter Chart method)

All observed costs at different activity levels are plotted on a graph. Based on a sound judgment, a regression line is then fitted to the plotted points to represent the line function.

3) LEAST-SQUARES REGRESSION method

A statistical technique that determines the "line of best fit" for all the data points by minimizing the sum of the squared deviations between line and the data points. Regression analysis is classified as:

Regression Analysis	Example	Dependent Variable	Independent Variable
SIMPLE	$Y = a + bX$	1	1
MULTIPLE	$Y = a + bX + cZ$	1	2 or more

4) Other cost estimation methods:

- INDUSTRIAL ENGINEERING** method - study between physical inputs and outputs especially meant for totally new activities; engineering estimates indicate what how much costs should be.
- ACCOUNT Analysis** method - each account is classified as either fixed or variable based on experience and judgment of accounting and other qualified personnel in the organization.
- CONFERENCE** method - costs are classified based on opinions from various company departments such as purchasing, process engineering, manufacturing, employee relations and so on.

CORRELATION ANALYSIS

CORRELATION ANALYSIS is used to measure the strength of linear relationship between two or more variables. The correlation between two variables can be seen by drawing a scatter diagram.

COEFFICIENT OF CORRELATION (r) measures the relative strength of linear relationship between two (2) variables. Its value ranges from - 1.0 to + 1.0:

	"r"	Linear Relationship	Scatter Diagram/Graphical Representation
Perfect Positive correlation	+1.0	Direct/Positive	Upward Sloping Line
No Correlation	0	None	No Apparent Pattern (Random Points)
Negative Correlation	-1.0	Inverse/Negative	Downward Sloping Line

COEFFICIENT OF DETERMINATION (r^2) indicates the degree to which the behavior of independent variable predicts the dependent variable. The closer r^2 is to 1.0, the better (i.e., more confidence) the independent variable predicts the behavior of the dependent variable.

Correlation analysis does not establish cause-&-effect pattern; it merely indicates a linear relationship.

EXERCISES: COST BEHAVIOR with REGRESSION ANALYSIS

1. Variable Costs vs. Fixed Costs

Sydney Company manufactures and sells a single product. A partially completed schedule of costs over a relevant range of 20 to 60 units produced each week is given below:

Constant regardless of activity:

1. Total Fixed Cost

2. Variable Cost per Unit

		Units Produced		
		(I) 20 units	(II) 40 units	(III) 60 units
<u>TOTAL COSTS</u>				
Variable costs	(A) $20 \times 2 = 40$?	$40 \times 2 = 80$?	$60 \times 2 = 120$?	
Mixed costs / Constant Fixed costs	(B) 600 ?	P 600	600 ?	
Semi Variable Costs --> Total costs	(C) 640 ?	680 ?	720 ?	
<u>PER UNIT COSTS</u>				
Variable costs	(D) P 2	2 ?	2 ?	
Fixed costs	(E) $600/20 = 30$?	$600/40 = 15$?	$600/60 = 10$?	

REQUIRED:

- Determine the correct amounts of those with (?) mark.
- Which specific costs (2) remain constant over the relevant range? B & D
- Which specific costs (2) are directly related with production? A & C
- Which specific cost is inversely related with production? E - FC per unit
- Express the cost formula based on the line equation form 'Y = a + bX.' $Y = 600 + 2X$
- If Sydney plans to produce 50 units, then how much is the expected total costs?
 $Y = 600 + 2(50)$ $Y = 700$

2. High-Low Method

The controller of Deadball Hospital would like to come up with a cost formula that links Admission Department cost to the number of patients admitted during a month. The Admission Department's costs and the number of patients admitted during the past nine months follow:

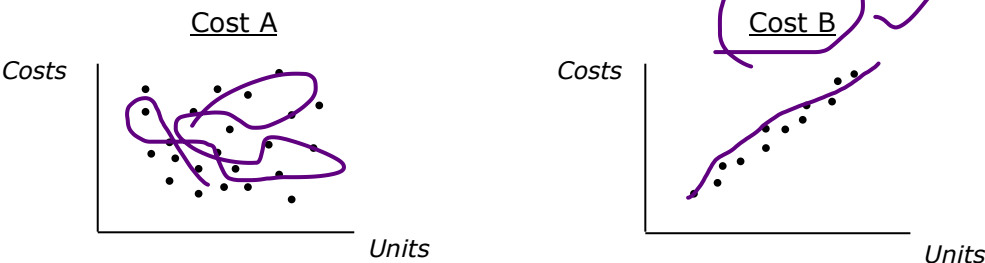
X is the basis for high & low		Month	Number of Patients	Admission Department's Cost	
		April	18	P 15,600	
High		May	19	P 15,200	
		June	17	P 13,700	
		July	15	P 14,600	
		August	15	P 14,300	
		September	11	P 13,200	
		October	11	P 12,800	Low
Outlier - abnormal ignore		November	48	P 72,500	common X choose the lower cost
		December	16	P 14,000	

REQUIRED: Using the high-low method, determine the admission department's:

- Variable cost per unit $12,800 - 3,300 = a = 9,500 \times 12 \text{ mos} = 114,000$
- Total annual fixed costs 114,000
- Monthly cost function $Y = 9,500 + 300 X$
- Estimated cost assuming 12 patients will be admitted next month. $Y = 9,500 + 300 (12)$
 $y = 13,100$

3. Correlation Analysis

3A) Looking at the following scatter diagrams, we can conclude that:



- Cost A will be easier to predict than cost B.
 - Cost B will be easier to predict than cost A.
 - Cost B has no variable component.
 - Cost A is out-of-control.
- 3B) If the coefficient of correlation (r) between two variables is +1, then a scatter diagram will appear to be a regression line that
- Slopes downward to the right
 - Slopes upward to the right
 - Slopes upward to the left
 - Appears to be vertical
- 3C) Which correlation coefficient represents strongest relationship between two variables?
- + 0.50
 - 0.75
 - 0.05
 - + 1.05

4. Least-Squares Regression Method

Tong Company's total overhead costs at various levels of activity are presented below:

	X Machine Hours	Y Total Overhead Costs
Week 40	30	P 340
100/20 = 5 Week 41	20	P 250
Week 42	50	P 520
Week 43	total x=90 40	total y=1540 P 430

The breakdown of the overhead costs in Week 41 at 20 machine-hour level of activity is as follows:

Supplies (Variable)	P 100	Week 42 250 5x50
Salaries (Fixed)	40	40
Maintenance (Mixed)	110	230 (250+40) - 520
Total	P 250	520

REQUIRED:

- How much of Week 42's overhead cost of P 520 consisted of maintenance cost? 230
- Using high-low method, determine the cost function for maintenance costs. $Y = a + 4x$
 $110 = a + 4(20)$
 $a = 30$
- Using high-low method, determine the cost function for total overhead costs. $Y = 30 + 4x \rightarrow$ Maintenance
- Using least-squares method, determine the cost function for total overhead costs.
- What would be the estimated overhead costs if Week 44 expects to operate at 45 machine hours?

$Y = 70 + 9(45)$
 $Y = 445$

SOLUTION GUIDE (Requirement 1)

	Week 41 (20 hours)	Week 42 (50 hours)
Supplies (Variable)	100/20 = 5 vc/u P 100	5x50 = 250
Salaries (Fixed)	40	40
Maintenance (Mixed)	110	230 squeeze
Total Overhead Costs	P 250	P 520

$\frac{230 - 110}{50 - 20} = 4$

$Y = a + 4x$
 $110 = a + 4(20)$
 $a = 30$

$Y = 30 + 4x \rightarrow$ Maintenance

$\frac{520 - 250}{50 - 20} = 9$

$y = a + 9x$
 $250 = a + 9(20)$
 $a = 70$

$y = 70 + 9x \rightarrow$ Total OVH cost

SOLUTION GUIDE (Requirement 4: Least-Squares Regression Method)

$Ey = na + bEx$
 $Exy = Exa + bEx^2$

$1,540 = 4a + 140b$
 $58,400 = 140a + 5,400b$
(1st equation x 35 to clear a)

$58,400 = 140a + 5,400b$
 $53,900 = 140a + 4,900b$

$4,500 = 500b$
 $b = 9$

$1540 = 4a + 140(9)$
 $1540 - 1260 = 4a$
 $a = 70$

$Y = 70 + 9x$

WRAP-UP EXERCISES

(Sources: CMA/CIA/RPCPA/AICPA/Various test banks)

- Which of the following costs is most likely a fixed cost?
 - P 4 per unit at 10 units; P 4 per unit at 20 units; P 4 per unit at 30 units 40(10), 80(20), 120(30) = Variable Costs
 - P 12 per unit at 10 units; P 6 per unit at 20 units; P 4 per unit at 30 units all are 120
 - P 3 per unit at 10 units; P 2.5 per unit at 20 units; P 2.33 per unit at 30 units
 - P 4 per unit at 10 units; P 3 per unit at 20 units; P 2.67 per unit at 30 units
- In cost analysis using the line equation $Y = a + bX$, "b" (unit variable cost) is regarded as the
 - Dependent variable
 - Independent variable
 - Slope of the line
 - Y-axis intercept
- A company has developed a production cost function for its lone product: $Y = 20 + 3X$, where X is based on the number of labor hours. Based on a relevant range of 10 to 20 labor hours, what is the estimated production cost at zero (0) labor hour?
 - P 20 20 will be the answer if relevant range is not given
 - P 50
 - P 80 0 is outside the relevant range so it cannot be determined if its outside the range (different cost behavior pattern)
 - The exact amount cannot be determined without additional information
- When compared to the high-low method, the graphic approach to cost estimation is usually
 - Less accurate
 - Equally representative
 - More representative
 - Less representative
- What is the appropriate range for the coefficient of determination (r^2)?
 - 0 to +1
 - 0 to -1
 - 1 to 0
 - 1 to +1
- Which of the following corresponds to (1) line of VISUAL FIT method and (2) line of BEST FIT method?
 - (1) High-Low method (2) Scattergraph method
 - (1) Scattergraph method (2) Least-Squares regression method
 - (1) High-Low method (2) Least-Squares regression method
 - (1) Least-Squares regression method (2) Scattergraph method
- What cost segregation method gives the most mathematically precise cost estimate?
 - Scatter diagram method
 - Least-squares method
 - High-low method
 - Calendar method
- Using statistical normal relationships, the least-squares method uses which of the following equations?
 - $y = na + bx$
 $\Sigma xy = a\Sigma x + b\Sigma x^2$
 - $y = na + b\Sigma x$
 $\Sigma xy = ax + b\Sigma x$
 - $\Sigma y = a + bx^2$
 $\Sigma y = na + b\Sigma x$
 - $\Sigma y = na + b\Sigma x$
 $\Sigma xy = a\Sigma x + b\Sigma x^2$



Weeks 1 & 2: COST BEHAVIOR with REGRESSION ANALYSIS

9. Multiple regression analysis involves the use of
- a. One dependent variable and one independent variable
 - b. One dependent variable and many independent variables
 - c. Many dependent variables and one independent variable
 - d. Many dependent variables and many independent variables
10. Under Cost-Volume-Profit (CVP) analysis, a mixed cost should be:
- a. Disregarded
 - b. Treated as a fixed cost
 - c. Treated as a variable cost
 - d. Separated into fixed & variable components

SELF-TEST QUESTIONS (with suggested answers)

1. Which of the following is the best example of a variable cost?
- C
- a. Property taxes
 - b. Interest charges
 - c. Cost of raw material
 - d. Corporate president's salary
2. Manda Company has the following cost components for 100,000 units of product for the year:
- | | |
|-------------------------------------|-----------|
| Direct materials | P 200,000 |
| Direct labor | 100,000 |
| Manufacturing overhead | 200,000 |
| Selling and administrative expenses | 150,000 |
- All costs are variable, except for P 100,000 of manufacturing overhead and P 100,000 of selling and administrative expenses. The total costs to produce and sell 110,000 units for the year are
- B
- a. P 715,000
 - b. P 695,000
 - c. P 650,000
 - d. P 540,000
3. Which of the following categories of cost is most likely not considered a component of fixed factory overhead?
- B
- a. Rent
 - b. Power
 - c. Depreciation
 - d. Property taxes
4. Which of the following statements is true?
- D
- a. The higher is the production within the relevant range, the higher is the variable cost per unit
 - b. The higher is the production within the relevant range, the higher is the fixed cost per unit
 - c. The lower is the production within the relevant range, the lower is the total fixed cost
 - d. The lower is the production within the relevant range, the lower is the total variable cost
5. Within the relevant range, the amount of variable cost per unit
- D
- a. Differs at each production level
 - b. Increases as production increases
 - c. Decreases as production increases
 - d. Remains constant at each production level
6. Which of the following best describes a fixed cost?
- C
- a. It is constant per unit of changes in production.
 - b. It may change in total when such change is related to changes in production.
 - c. It may change in total when such change is unrelated to changes in production.
 - d. It may change in total when such change depends upon production or within the relevant range.
7. Committed fixed costs
- C
- a. Can never be changed
 - b. Can usually be changed in the short run
 - c. Are difficult to change in the short run
 - d. Are the result of factors outside the organization
8. What would be an example of a discretionary fixed cost?
- D
- a. Depreciation on equipment
 - b. Rent on a factory building
 - c. Salaries of top management
 - d. Research and development
9. A cost that is fixed over a short range of activity, then rises abruptly and remains fixed over another short range is called
- A
- a. Step cost
 - b. Fixed cost
 - c. Mixed cost
 - d. Variable cost
10. Which of the following best describes a step cost?
- D
- a. It is partly variable and partly fixed
 - b. It remains constant in all cases
 - c. It increases proportionately with volume
 - d. It increases abruptly outside the relevant range
11. Mixed costs or semi-variable costs
- B
- a. Do not exist
 - b. Are part fixed and part variable
 - c. Are variable costs which increase gradually
 - d. Are ignored in cost analysis because they are difficult to interpret
12. The fixed cost of a semi-variable cost is comparable to the mathematical concept of
- A
- a. Y-intercept
 - b. Slope of the line
 - c. Dependent variable
 - d. Independent variable
13. In describing the cost formula equation $Y = a + bX$, which of the following statements is correct?
- D
- a. 'Y' is the independent variable
 - b. 'a' is the variable rate
 - c. 'a' and 'b' are valid for all levels of activity
 - d. In the high-low method, 'b' equals the change in cost (Y) divided by the change in activity (X)
14. Rambong, Inc. applies the high-low method of cost estimation to customer order data for the first 4 months of 2022:
- | Month | Orders | Cost (P) |
|----------|--------|----------|
| January | 1,200 | 3,120 |
| February | 1,300 | 3,185 |
| March | 1,800 | 4,320 |
| April | 1,700 | 3,895 |
- What is the estimated variable cost component per order?
- A
- a. P 2.00
 - b. P 2.42
 - c. P 2.48
 - d. P 2.50



Weeks 1 & 2: COST BEHAVIOR with REGRESSION ANALYSIS

15. Magna Company estimated its materials handling cost at two activity levels as follows:

Kilos Handled	Cost
80,000	160,000
60,000	132,000

$$\begin{aligned} 160k - 132k &= b(1.40) \\ 80k - 60k &= b(1.40) \\ 132k &= a + 1.40(60k) \\ a &= 48,000 \\ Y &= 48k + 1.40(75K) \\ Y &= 153,000 \end{aligned}$$

What is Magna's **estimated cost for handling 75,000 kilos?**

- B a. P 150,000 c. P 157,500
b. **P 153,000** d. P 165,000

16. In March, Nakaw Company had electrical costs of P 225.00 when the total volume was 4,500 units. In April, electrical costs were P 227.50 for 4,750 units. Using the high-low method, what is the **estimated fixed cost of electricity per year?**

- D a. P 180 c. P 225
b. P 200 d. **P 2,160** $a = 180 \times 12 \text{ mos} = 2,160$

17. Martial Company uses the high-low method to derive the cost formula for electrical power cost. According to the cost formula, the variable cost per unit of activity is P 3 per machine hour. Total electrical power cost at the high level of activity was P 7,600 and the low level of activity was P 7,300. If the high level of activity was 1,200 machine-hours, then what was the low level of the activity?

- D a. 800 machine-hours c. 1,000 machine-hours
b. 900 machine-hours d. **1,100 machine-hours**

$$\begin{aligned} \frac{7600 - 7300}{1200 - x} &= 3 \\ \frac{300}{1200 - x} &= 3 \\ \frac{3600 - 3x}{1200 - x} &= 300 \\ 3600 - 3x &= 300 \\ 3300 &= -3x \\ x &= 1100 \end{aligned}$$

18. Militar Co. has an average unit cost of P 45 at 10,000 units and P 25 at 30,000 units. What is the unit variable cost?

- B a. P 10.00
b. **P 15.00**
c. P 20.00
d. An amount that cannot be determined without more information

Average unit cost = Total Costs ÷ Number of units

$$\begin{aligned} \frac{750,000 - 450,000}{30,000 - 10,000} &= 15 \end{aligned}$$

19. Total production costs of prior periods for a company are listed below. Assume that the same cost behavior patterns can be extended linearly over the range of **3,000 to 35,000 units** and that the cost driver for each product is the number of units produced.

Production per month (units)	3,000	9,000	16,000	35,000
Product X	P 23,700	P 52,680	P 86,490	P 178,260
Product Y	47,280	141,840	252,160	551,600

$$23700 / 3000 = 7.9$$

What is the average cost per unit at a production level of 8,000 units for product X?

- B a. P 7.90 c. P 5.85
b. **P 5.98** d. P 4.83

20. Liar, Inc. provides you with the following flexible budget of factory overhead at three different capacity levels:

Capacity	Factory Overhead
60%	P 98,000
70%	106,000
85%	118,000

What will be the flexible budget of factory overhead at 90% capacity?

- B a. P 112,000 c. P 130,000
b. **P 122,000** d. P 132,000

21. The high-low method **may give unsatisfactory** results if:

- D a. Volume is low c. Data points all fall on a line
b. Volume is heavy d. **Data points are unrepresentative**

22. The method of cost analysis in **which the accountant draws a straight line through plotted points, keeping as close as possible to the majority of the points**, is called:

- B a. High-low method c. Simple regression approach
b. **Graphic approach** d. Multiple regression approach

23. A data point that **falls far away from other data points in a scatter diagram** is called a (an)

- A a. **Outlier** c. Standard deviation
b. Margin of error d. Coefficient of determination

24. The major objective of preparing a scatter diagram is to

- B a. Determine the relevant range
b. **Derive an equation to predict future costs**
c. Perform regression analysis on the results
d. Find the high and low points to use for the high-low method of estimating costs

25. The principal advantage of the scatter-diagram method over the high-low method is that the scatter-diagram method

- A a. **Considers more than two points**
b. Includes cost outside the relevant range
c. Gives a precise mathematical fit of the points to the line
d. Can be used with more types of costs than the high-low method

26. Which is an equation required for **applying least square method of computing fixed and variable costs?**

- C a. $\Sigma y = a\Sigma x + b\Sigma x^2$ c. **$\Sigma y = na + b\Sigma x$**
b. $\Sigma xy = na + b\Sigma x$ d. $\Sigma xy = na + b\Sigma x^2$

27. An analysis of maintenance cost at four levels of plant operations is shown below:

Hours	Cost	Hours x cost	Hours Squared
40	P 1,000	40,000	1,600
30	900	27,000	900
60	1,300	78,000	3,600
50	1,150	57,500	2,500
180	P 4,350	202,500	8,600

$$\begin{aligned} 4350 &= 4a + 180b \\ 202500 &= 180a + 8600b \\ 1st \text{ eq} \times 45 \text{ to cancel } a \\ 202500 &= 180a + 8600b \\ 195750 &= 180a + 8100b \\ 6750 &= 500b \\ b &= 13.5 \end{aligned}$$

Under the least-squares regressions method, how much is **the fixed cost of the maintenance?**

- A a. **P 480** c. P 520
b. P 500 d. P 600

$$\begin{aligned} 4350 &= 4a + 180(13.5) \\ a &= 480 \end{aligned}$$



28. The following cost data are made available by Oxford Manufacturing Company for your analysis:

Number of Months	10
Sum of Hours	350
Sum of Costs	1,000
Sum of Hours x Costs	39,200
Sum of Hours Squared	14,250

$$\begin{aligned} 1000 &= 10a + 350b \\ 39200 &= 350a + 14250b \\ \text{1st eq} \times 35 \text{ to cancel } a \\ \hline 39200 &= 350a + 14250b \\ 35000 &= 350a + 12250b \\ \hline 4200 &= 2000b \\ b &= 2.1 \end{aligned}$$

How much is the monthly fixed cost?

- A a. P 26.50 c. P 318.00
b. P 35.00 d. P 420.00

$$\begin{aligned} 1000 &= 10a + 350(2.1) \\ a &= 26.50 \end{aligned}$$

29. Simple regression analysis involves

- A a. One dependent variable and one independent variable
b. One dependent variable and many independent variables
c. Many dependent variables and one independent variable
d. Many dependent variables and many independent variables

30. In determining cost behavior, the cost function is often expressed as $Y = a + bX$. Which of the following cost estimation methods should not be used in estimating fixed and variable costs for the equation?

- D a. Graphic method c. High and low point
b. Simple regression d. Multiple regression

31. A scatter diagram that manifests a regression line sloping down to the right would most likely show a correlation coefficient (r) of

- C a. + 0.95 c. - 0.95
b. + 9.50 d. - 9.50

32. If coefficient of correlation (r) between two variables is zero, how might a scatter diagram of these variables appear?

- A a. Random points
b. A least squares line that slopes up to the right
c. A least squares line that slopes down to the right
d. Under this condition, a scatter diagram could not be plotted on a graph.

33. R-squared (r^2) is a measure of

- D a. The fixed cost component
b. The variable cost per unit of activity
c. The spurious relationship between cost and activity
d. How well the regression line accounts for the changes in the dependent variable

34. After constructing a scatter chart, the internal auditor of Madagascar Company provided you with the following information:

Independent variable: 1,000,000
Slope of the line: 0.25
Y-axis intercept: 7,500

$$\begin{aligned} Y &= 7500 + 1,000,000 (0.25) \\ Y &= 257,500 \end{aligned}$$

Based on the above data, what is the estimated cost?

- B a. P 250,500 c. P 1,000,000
b. P 257,500 d. P 1,007,500

35. Tax Evader Company uses regression analysis to develop a model for predicting overhead costs. Two different cost drivers (machine hours and direct materials weight) are under consideration as the independent variable. Relevant data were run on a computer using one of the standard regression programs, with the following results:

	Coefficient		Coefficient
MACHINE HOURS		DIRECT MATERIALS WEIGHT	
Y-intercept	2,500	Y-intercept	4,600
B	5.0	B	2.6
$r^2 = 0.70$		$r^2 = 0.50$	

What regression equation should be used?

- A a. $Y = 2,500 + 5.0X$ c. $Y = 4,600 + 2.6X$
b. $Y = 2,500 + 3.5X$ d. $Y = 4,600 + 1.3X$

36. The statistician of Never-Again has developed the following cost-prediction equation, using observations from 12,000 to 30,000 machine hours:

- $Y = P 236,837 + 3.7625X$
- R-squared = 0.81
- Standard error = P 24,363
- Several 'outliers' are noted within tolerable limits
- Y (dependent variable) = total maintenance cost
- X (independent variable) = machine hours

36A) What percentage of the variation in maintenance costs is explained by the independent variable?

- C a. 95% c. 81%
b. 90% d. 66%

NOTE: R-squared (r^2) or the coefficient of determination is a statistical measure of fit that indicates how much variation of a dependent variable is explained by the independent variable(s) in a regression model. See item no. 33.

36B) Compute the estimated maintenance cost at 20,000 machine hours.

- C a. P 252,790 c. P 312,087
b. P 287,724 d. P 336,450

$$\begin{aligned} Y &= 236837 + 3.7625 (20,000) \\ Y &= 312,087 \end{aligned}$$

NOTE: $Y = 236,837 + 3.7625 (20,000)$. In estimating costs using line functions, standard error is ignored.