Chapter 3

COST BEHAVIOR ANALYSIS

MULTIPLE CHOICE

Question Nos. 12-14 and 20-25 are AICPA adapted.
Question Nos. 16-19 and 28 are ICMA adapted.
Question Nos. 15, 26, and 28 are CIA adapted.

D 1. Expenses that require a series of payments over a long period of time—such as long-term debt and lease rentals—are frequently known as:
- **A. programmed fixed expenses**
- **B. avoidable expenses**
- **C. variable expenses**
- **D. committed fixed expenses**
- **E. normal capacity expenses**

C 2. A mathematical technique used to fit a straight line to a set of plotted points is:
- **A. integral calculus**
- **B. the EOQ model**
- **C. the method of least squares**
- **D. linear programming**
- **E. PERT network analysis**

E 3. One advantage of using multiple regression analysis is that:
- **A. computations are simplified**
- **B. only two data points need be considered**
- **C. a two-dimensional graph may be used to show cost relationships**
- **D. costs may be grouped into one independent variable**
- **E. the effects of several variables on costs may be analyzed**

B 4. The coefficient of determination indicates:
- **A. causal relationships among costs and other factors**
- **B. the percentage of explained variance in the dependent variable**
- **C. the linear relationship between two variables**
- **D. whether several variables fluctuate**
- **E. the size of the standard deviation**

E 5. Hoyden Co. developed the following equation to predict certain components of its budget for the coming period:

Costs = $50,000 + ($5 x direct labor hours)

The $5 would approximate:
A. total cost
B. direct labor rate per hour
C. fixed cost per direct labor hour
D. the coefficient of determination
E. variable costs per direct labor hour

E 6. When cost relationships are linear, total variable manufacturing costs will vary in proportion to changes in:
A. machine hours
B. direct labor hours
C. total material cost
D. total overhead cost
E. volume of production

B 7. The term "relevant range" as used in cost accounting means the range over which:
A. relevant costs are incurred
B. cost relationships are valid
C. costs may fluctuate
D. sales volume fluctuates
E. production may vary

E 8. Within a relevant range, the amount of fixed cost per unit:
A. differs at each production level on a per-unit basis
B. remains constant in total
C. decreases as production increases on a per-unit basis
D. increases as production decreases on a per-unit basis
E. all of the above

C 9. The following relationships pertain to a year's budgeted activity for Buckeye Company:

	High	**Low**
Direct labor hours	**400,000**	**300,000**
Total costs...	**$154,000**	**$129,000**

What are the budgeted fixed costs for the year?
A. $100,000
B. $25,000
C. $54,000
D. $75,000
E. none of the above

SUPPORTING CALCULATION:

High	**$ 154,000**	**400,000**
Low	**129,000**	**300,000**
Difference	**$ 25,000**	**100,000**

Variable rate = $25,000 ÷ 100,000 = $.25/direct labor hour
Fixed cost = $154,000 - $.25(400,000) = $54,000

B 10. Maintenance expenses of a company are to be analyzed for purposes of constructing a flexible budget. Examination of past records disclosed the following costs and volume measures:

	High	**Low**
Cost per month	**$39,200**	**$32,000**
Machine hours	**24,000**	**15,000**

Using the high-low method of analysis, the estimated variable cost per machine hour is:
A. $12.50
B. $0.80
C. $0.08
D. $1.25
E. none of the above

SUPPORTING CALCULATION:

High	**$ 39,200**	**24,000**
Low	**32,000**	**15,000**
Difference	**$ 7,200**	**9,000**

Variable rate = $7,200 ÷ 9,000 = $.80/machine hour

D 11. A company allocates its variable factory overhead based on direct labor hours. During the past three months, the actual direct labor hours and the total factory overhead allocated were as follows:

	October	**November**	**December**
Direct labor hours	**2,500**	**3,000**	**5,000**
Total factory overhead allocated	**$80,000**	**$75,000**	**$100,000**

Based upon this information, the estimated variable cost per direct labor hour was:
A. $.125
B. $12.50
C. $.08
D. $8
E. none of the above

SUPPORTING CALCULATION:

High	**$ 100,000**	**5,000**
Low	**80,000**	**2,500**
Difference	**$ 20,000**	**2,500**

Variable rate = $20,000 ÷ 2,500 = $8.00/direct labor hour

A 12. The technique that can be used to determine the variable and fixed portions of a company's costs is:
- **A. scattergraph method**
- **B. poisson analysis**
- **C. linear programming**
- **D. game theory**
- **E. queuing theory**

A 13. The number of variables used in simple regression analysis is:
- **A. two**
- **B. three**
- **C. more than three**
- **D. three or less**
- **E. one**

C 14. Multiple regression analysis:
- **A. is not a sampling technique**
- **B. involves the use of independent variables only**
- **C. assumes that the independent variables are not correlated**
- **D. establishes a cause-and-effect relationship**
- **E. all of the above**

E 15. For a simple regression-analysis model that is used to allocate factory overhead, an internal auditor finds that the intersection of the line of best fit for the overhead allocation on the y-axis is $50,000. The slope of the trend line is .20. The independent variable, factory wages, amounts to $900,000 for the month. What is the estimated amount of factory overhead to be allocated for the month?
- **A. $910,000**
- **B. $950,000**
- **C. $ 50,000**
- **D. $180,000**
- **E. $230,000**

SUPPORTING CALCULATION:

Factory overhead = $50,000 + .2($900,000) = $230,000

A 16. As a result of analyzing the relationship of total factory overhead to changes in machine hours, the following relationship was found:

***y* bar = $1,000 + $2 *x* bar**

This equation was probably found by using the mathematical techniques called:
A. simple regression analysis
B. dynamic programming
C. linear programming
D. multiple regression analysis
E. none of the above

A 17. As a result of analyzing the relationship of total factory overhead to changes in machine hours, the following relationship was found:

***y* bar = $1,000 + $2 *x* bar**

The *y* bar in the equation is an estimate of:
A. total factory overhead
B. total fixed costs
C. total machine costs
D. total variable costs
E. none of the above

C 18. As a result of analyzing the relationship of total factory overhead to changes in machine hours, the following relationship was found:

***y* bar = $1,000 + $2 *x* bar**

The $2 in the equation is an estimate of:
A. fixed costs per machine hour
B. total fixed costs
C. variable costs per machine hour
D. total variable costs
E. none of the above

D 19. As a result of analyzing the relationship of total factory overhead to changes in machine hours, the following relationship was found:

***y* bar = $1,000 + $2 *x* bar**

The use of such a relationship of total factory overhead to changes in machine hours is said to be valid only within the relevant range, which means:
A. within the range of reasonableness as judged by the department supervisor
B. within the budget allowance for overhead
C. within a reasonable dollar amount for machine costs
D. within the range of observations of the analysis
E. none of the above

C 20. **A measure of the extent to which two variables are related linearly is referred to as:**
- **A. sensitivity analysis**
- **B. input-output analysis**
- **C. coefficient of correlation**
- **D. cause-effect ratio**
- **E. cost-benefit analysis**

C 21. **The appropriate range for the coefficient of correlation *(r)* is:**
- **A. -infinity $\leq r \leq$ infinity**
- **B. $0 \leq r \leq 1$**
- **C. $-1 \leq r \leq 1$**
- **D. $-100 \leq r \leq 100$**
- **E. none of the above**

A 22. **The covariation between two variables, such as direct labor hours and electricity expense, can best be measured by:**
- **A. correlation analysis**
- **B. simple regression analysis**
- **C. multiple regression analysis**
- **D. high-low method**
- **E. scattergraph method**

B 23. **The quantitative method that will separate a semivariable cost into its fixed and variable components with the highest degree of precision is:**
- **A. simplex method**
- **B. least squares method**
- **C. scattergraph method**
- **D. account analysis**
- **E. high-low method**

A 24. **If the coefficient of correlation between two variables is zero, a scatter diagram of these variables would appear as:**
- **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**
- **E. none of the above**

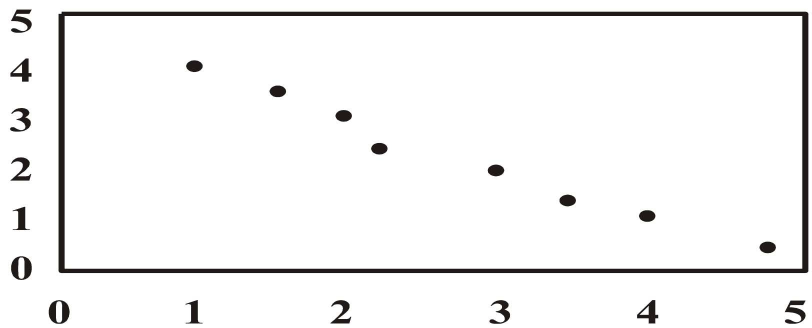
D 25. **Multiple regression analysis involves the use of:**

	Dependent Variables	Independent Variables
A.	1	none
B.	1>	1
C.	1>	1>
D.	1	1>

C 26. **A company using regression analysis to correlate income to a variety of sales indicators found that the relationship between the number of sales managers in a territory and net income for the territory had a correlation coefficient of -1. The best description of this situation is:**
- **A. that more sales managers should be hired**
- **B. imperfect negative correlation**
- **C. perfect inverse correlation**
- **D. no correlation**
- **E. perfect positive correlation**

B 27. **The correlation coefficient that indicates the weakest linear association between two variables is:**
- **A. -0.73**
- **B. -0.11**
- **C. 0.12**
- **D. 0.35**
- **E. 0.72**

B 28. **If regression was applied to the data shown in Figure 3-1, the coefficients of correlation and determination would indicate the existence of a:**



- **A. low linear relationship, high explained variation ratio**
- **B. high inverse linear relationship, high explained variation ratio**
- **C. high direct linear relationship, high explained variation ratio**
- **D. high inverse linear relationship, low explained variation ratio**
- **E. none of the above**

A 29. **Omitting important variables from the multiple regression is referred to as a(n):**
- **A. specification error**
- **B. autocorrelation**
- **C. confidence loss**
- **D. homoscedastic error**
- **E. heteroscedastic error**

E 30. **When two or more independent variables are correlated with one another, the condition is referred to as:**
- **A. serial correlation**
- **B. autocorrelation**
- **C. heteroscedacity**
- **D. homoscedacity**
- **E. multicollinearity**

A 31. **A large value for standard error of the estimate indicates that:**
- **A. the actual cost will likely vary greatly from the estimated cost as portrayed by the regression line**
- **B. the actual cost will be greater than the estimate cost as portrayed by the regression line**
- **C. the actual cost will be less than the estimate cost as portrayed by the regression line**
- **D. the actual cost will likely vary little from the estimated cost as portrayed by the regression line**
- **E. none of the above**

D 32. **The confidence interval represents:**
- **A. the percentage of variance in the dependent variable as explained by the independent variable**
- **B. the measure of the extent to which variables are related linearly**
- **C. the standard deviation about the regression line**
- **D. a range of values within which the dependent variable is expected to fall a certain percentage of the time**
- **E. none of the above**

C 33. **When the distribution of observations around the regression line is uniform for all values of the independent variable, it is:**
- **A. heteroscedastic**
- **B. serially correlated**
- **C. homoscedastic**
- **D. autocorrelated**
- **E. none of the above**

E 34. **Expenses that are fixed at management's discretion at a certain level for the period are referred to as:**
- **A. committed fixed costs**
- **B. mixed costs**
- **C. opportunity costs**
- **D. sunk costs**
- **E. programmed fixed costs**

A 35. **The separation of fixed and variable costs is necessary for all of the following purposes *except*:**
- **A. absorption costing and net income analysis**
- **B. direct costing and contribution margin analysis**
- **C. break-even and cost-volume-profit analysis**
- **D. differential and comparative cost analysis**
- **E. capital budgeting analysis**

PROBLEMS

PROBLEM

1.
High and Low Points Method. A controller is interested in analyzing the fixed and variable costs of indirect labor as related to direct labor hours. The following data have been accumulated:

Month	Indirect Labor Cost	Direct Labor Hours
March	$2,880	425
April	3,256	545
May	2,820	440
June	3,225	560
July	3,200	540
August	3,200	495

Required: **Determine the amount of the fixed portion of indirect labor expense and the variable rate for indirect labor expense, using the high and low points method. (Round the variable rate to three decimal places and the fixed cost to the nearest whole dollar.)**

SOLUTION

	Indirect Labor Cost	Direct Labor Hours
High	$ 3,225	560
Low	2,880	425
Difference	$ 345	135

Variable rate = $345 ÷ 135 = $2.556 per direct labor hour
Fixed cost = $3,225 - ($2.556 x 560) = $1,794

PROBLEM

2.
Fixed, Variable, and Semivariable Production Costs. Ibus Instruments Co. developed the following regression equations to indicate costs at various activity levels:

Direct labor	=	$4 per unit
Materials	=	$3 per unit
Supervision	=	$5,000
Power	=	$300 + $.25 per unit + $.50 per machine hour
Factory supplies	=	$250 + $.75 per unit
Depreciation—equipment	=	$1 per machine hour
Depreciation—building	=	$10,000

During the next period, the company anticipates production of 20,000 units and usage of 3,000 machine hours.

Required: **Prepare a schedule of the production costs to be incurred during the next period.**

SOLUTION

Production costs:		
Direct labor		**$ 80,000**
Direct materials		**60,000**
Overhead to be incurred:		
Supervision	**$ 5,000**	
Power [$300 + ($.25 x 20,000 units) + ($.50 x 3,000 machine hours)]	**6,800**	
Factory supplies [$250 + ($.75 x 20,000 units)]	**15,250**	
Depreciation—equipment	**3,000**	
Depreciation—building	**10,000**	**40,050**
Total production cost		**$ 180,050**

PROBLEM

3.
Statistical Scattergraph. Dale Company management is interested in determining the fixed and variable components of electricity expense, a semivariable cost, as measured against machine hours. Data for the first eight months of the current year follow:

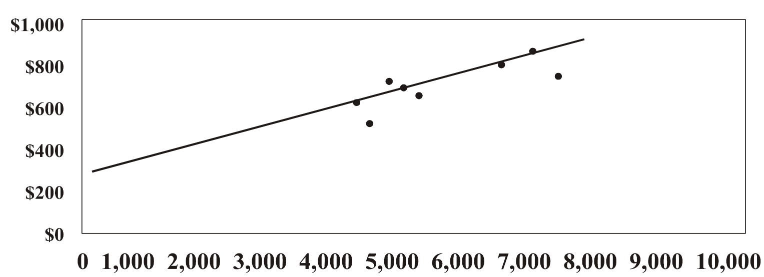
Month	**Machine Hours**	**Electricity Cost**
January	**4,500**	**$650**
February	**4,750**	**600**
March	**5,000**	**750**
April	**5,500**	**700**
May	**7,250**	**900**
June	**7,500**	**800**
July	**6,750**	**825**
August	**5,250**	**725**

***Required*: Graph the data provided and determine the total fixed cost and the variable cost per machine hour for electricity. (Round estimates to the nearest cent.)**

SOLUTION

Average cost ($5,950 ÷ 8)	**$743.75**
Fixed cost per month (from graph)	**200.00**
Average total variable cost	**$543.75**

$$\frac{\$543.75}{\$46{,}500 \div 8} = \$.0935 \text{ variable cost per machine hour}$$



PROBLEM

4.
Method of Least Squares. The management of Rainbow Inc. would like to separate the fixed and variable components of electricity as measured against machine hours in one of its plants. Data collected over the most recent six months follow:

Month	Electricity Cost	Machine Hours
January	$1,100	4,500
February	1,110	4,700
March	1,050	4,100
April	1,200	5,000
May	1,060	4,000
June	1,120	4,600

Required: **Using the method of least squares, compute the fixed cost and the variable cost rate for electricity expense. (Round estimates to the nearest cent.)**

SOLUTION

Month	(1) Electricity Cost	(2) Cost Deviation	(3) Machine Hours	(4) Activity Deviation	(5) (4) Squared	(6) (4) x (2)
January	$1,100	(7)	4,500	17	289	(119)
February	1,110	3	4,700	217	47,089	651
March	1,050	(57)	4,100	(383)	146,689	21,831
April	1,200	93	5,000	517	267,289	48,081
May	1,060	(47)	4,000	(483)	233,289	22,701
June	1,120	13	4,600	117	13,689	1,521
	$6,640	(2)*	26,900	2*	708,334	94,666

y **bar = Σ*y* ÷ *n* = $6,640 ÷ 6 = $1,107**

x **bar = Σ*x* ÷ *n* = $26,900 ÷ 6 = $4,483**

***rounding difference**

$$\text{Variable rate} = \frac{\text{Column (6)}}{\text{Column (5)}} = \frac{94{,}666}{708{,}334} = \$.13$$

Fixed cost = $1,107 - ($.13)(4,483) = <u>$524.21</u>

PROBLEM

5.
Coefficients of Correlation and Determination. The president of Scranton Steel Co. has prepared the following data so that an assessment may be made for developing a regression analysis of smelting costs:

Year	**Smelting Costs**	**Direct Labor Hours**	**Kilograms of Iron Smelted**
19_1	$12,000	2,100	50.2
19_2	12,900	1,800	55.6
19_3	13,500	2,250	60.0
19_4	12,750	2,400	54.0
19_5	14,100	2,250	64.4
Total	$65,250	10,800	284.2

Required: **Compute the coefficient of correlation (*r*) and the coefficient of determination (r^2) for each of the independent variables. (Round to three decimal places.)**

Note to instructor: **It may be helpful to provide students with the following equation:**

$$r = \frac{\Sigma\,[(x_i \bullet x \text{ bar})\,(y_i \bullet y \text{ bar})]}{\text{square root } [\Sigma\,(x_i \bullet x \text{ bar})^2\,\Sigma\,(y_i \bullet y \text{ bar})^2]}$$

SOLUTION

DIRECT LABOR HOURS

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Smelting Costs	Difference from Average of $13,050	Direct Labor Hours	Difference from Average of 2,160 Hours	(4) Squared	(4) x (2)	(2) Squared
$12,000	(1,050)	2,100	(60)	3,600	63,000	1,102,500
12,900	(150)	1,800	(360)	129,600	54,000	22,500
13,500	450	2,250	90	8,100	40,500	202,500
12,750	(300)	2,400	240	57,600	(72,000)	90,000
14,100	1,050	2,250	90	8,100	94,500	1,102,500
$65,250	0	10,800	0	207,000	180,000	2,520,000

$$r = \frac{\text{Column 6 total}}{\text{square root } [(\text{Column 5 total})\ (\text{Column 7 total})]}$$

$$r = \frac{\$180{,}000}{\text{square root } [(207{,}000)(\$2{,}520{,}000)]}$$

$$r = \frac{\$180{,}000}{\text{square root }(\$521{,}640{,}000{,}000)}$$

$$r = \frac{\$180{,}000}{\$722{,}246}$$

$$r = +.249$$

$$r^2 = .062$$

KILOGRAMS OF IRON SMELTED

(8) Kilograms of Iron Smelted	(9) Difference from Average of 56.84	(10) (9) Squared	(11) (9) x (2)
50.2	(6.64)	44.0896	$6,972
55.6	(1.24)	1.5376	186
60.0	3.16	9.9856	1,422
54.0	(2.84)	8.0656	852
64.4	7.56	57.1536	7,938
284.2	0.00	120.8320	$17,370

$$r = \frac{\text{Column 11 total}}{\text{square root }[(\text{Column 10 total})\ (\text{Column 7 total})]}$$

$$\text{r} = \frac{\$17{,}370}{\text{square root }[(120.832)\ (\$2{,}520{,}000)]}$$

$$\text{r} = \frac{\$17{,}370}{\text{square root }(\$304{,}496{,}640)}$$

$$\text{r} = \frac{\$17{,}370}{\$17{,}450}$$

$$\text{r} = .995$$

$$\text{r}^2 = .990$$

PROBLEM

6.

Standard Error of the Estimate and Confidence Interval Estimation. The production supervisor of Lyle Inc. would like to know the range of electricity cost that should be expected about 95 percent of the time at the 15,000 direct labor hour level of activity. The least squares estimate of electricity cost at that level of activity is $750. The least squares parameter estimates (i.e., the estimates of fixed cost and the variable cost rate) were derived from a sample of data for a recent 12-month period. The direct labor hour average for the sample period is 13,000, and the direct labor hour deviations from its average squared and summed $(\Sigma(x_i\text{-}x_i)^2)$ is 80,000,000. The prediction error squared $(\Sigma(y_i\text{-}y_i)^2)$ over the sample period is $40,850.

Required:

Compute:
(1) the standard error of the estimate
(2) the 95 percent confidence interval (Table factor 2.228) estimate for electricity cost at the 15,000 direct labor hour level of activity

(Round answers to the nearest whole dollar.)

SOLUTION

$$\text{square root}\left(\frac{\$40{,}850}{12 \bullet 2}\right) = \text{square root } \$4{,}085 = \$64$$

(1)

$$\$750 \pm (2.228)\ (\$64)\ \text{square root}\left(1 + \frac{1}{12} + \frac{(15{,}000 \bullet 13{,}000)^2}{80{,}000{,}000}\right)$$

$$\$750 \pm (2.228)\ (\$64)\ \text{square root } 1.1333$$
$$\$750 \pm (2.228)\ (\$64)\ (1.0645)$$
$$\$750 \pm \$152$$

(2)

PROBLEM

7.
Method of Least Squares. The data below are found to be highly correlated for Mystic Modem Manufacturing Corp.:

Fabricating Costs	Kilograms of Materials Used
$15,600	360
18,000	463
17,100	412
21,300	595
19,500	520
$91,500	2,350

Required:

(1) **Write an equation reflecting the relationship between fabricating costs and kilograms of materials used, using the method of least squares.**
(2) **Determine the standard error of the estimate.**
(3) **Determine the standard error of the estimate correction factor when direct labor hours are 500.**
(4) **Determine the coefficient of correlation *(r)* and the coefficient of determination *(r^2)*.**

(Round dollar amounts to the nearest cent and unit amounts to four decimal places.)

SOLUTION

(1)

(1) Fabricating Costs	(2) Difference from Average of $18,300	(3) Kilograms of Materials Used	(4) Difference from Average of 470	(5) (4) Squared	(6) (4) x (2)	(7) (2) Squared
$15,600	(2,700)	360	(110)	12,100	$297,000	$ 7,290,000
18,000	(300)	463	(7)	49	2,100	90,000
17,100	(1,200)	412	(58)	3,364	69,600	1,440,000
21,300	3,000	595	125	15,625	375,000	9,000,000
19,500	1,200	520	50	2,500	60,000	1,440,000
$91,500	0	2,350	0	33,638	$803,700	$19,260,000

$$\frac{\text{Column 6 total}}{\text{Column 5 total}} = \frac{\$803{,}700}{33{,}638} = \$23.89 \text{ variable rate per kg.}$$

$$
\begin{aligned}
y &= a + bx \\
\$18{,}300 &= a + (\$23.89 \times 470) \\
a &= \$18{,}300 - \$11{,}228.30 \\
a &= \$7{,}071.70 \\
\textbf{Equation: } y &= \$7{,}071.70 + \$23.89x
\end{aligned}
$$

(2)

(1) Kilograms of Materials Used	(2) Fabricating Costs	(3) Predicted Fabricating Costs	(4) Prediction Error (2) - (3)	(5) Prediction Error Squared (4) Squared
360	**$15,600**	**$15,672**	**$ (72)**	**$ 5,184**
463	**18,000**	**18,133**	**(133)**	**17,689**
412	**17,100**	**16,914**	**186**	**34,596**
595	**21,300**	**21,286**	**14**	**196**
520	**19,500**	**19,495**	**5**	**25**
2,350	**$91,500**	**$91,500**	**$ 0**	**$57,690**

$$\text{square root}\left(\frac{\Sigma(y_i \;\; y\text{ bar})^2}{n \;\; 2}\right) = \text{square root}\left(\frac{\text{Column 5 total}}{n \bullet 2}\right)$$

$$= \text{square root}\left(\frac{\$57{,}690}{5 \bullet 2}\right) = \$138.67$$

(3)

$$\text{square root}\left(1 + \frac{1}{n} + \frac{(x_i \bullet x\text{ bar})^2}{\Sigma\,(x_i \bullet x\text{ bar})^2}\right)$$

$$= \text{square root}\left(1 + \frac{1}{5} + \frac{(500 \bullet 470)^2}{33{,}638}\right) = 1.1076$$

(4)

$$r = \frac{(x_i \bullet x \text{ bar})(y_i \;\; y \text{ bar})}{\text{square root }[\Sigma (x_i \;\; x \text{ bar})^2 (y_i \bullet y \text{ bar})^2]}$$

$$\frac{\$803{,}700}{\text{square root }[(33{,}638)(\$19{,}260{,}000)]} = \frac{\$803{,}700}{\$804{,}902} = .9985$$

$$r^2 = .997$$